THE

ELECTRICAL REVIEW.

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CONTENTS:

	PAGE
The Electrical Treatment of Water Sewage and Garbage ...	249
A Method of Producing an Electric Arc (*illustrated*)	252
Electric Lighting Installation at the Bombay Government Dockyard	252
The Electric Welding of Rail Joints (*illustrated*)	253
Ship to Shore Communication (*illustrated*)	254
Reactance (*illustrated*)	254
Transformer Sub-Stations and Networks	256
The Maximum and Effective Pressure of Alternating Currents	256
The Hermite High Tension Electrolyser for Electrolysing Sea Water (*illustrated*)	257
The Pacific Cable	258
The United States New Tariff Act	259
Woodhouse & Rawson United, Limited	262
The Pathology and Treatment of Electric Accidents	262
Corres:—The Alleged New Constituent of the Atmosphere ...	263
Portable Batteries	263
Electrical Distribution by Alternating Currents	263
Personal	263
Notes	264
Business Notices, &c.	268
Contracts Open and Closed	269
City Notes, &c.	269
Traffic Receipts	269
Share List of Electrical Companies	270
The British Association:—	
A Direct-reading Form of Platinum Thermometer... ...	271
The Physical Condition of the Ocean	272
Experiments for Improving the Construction of Practical Standards for Electrical Measurements	272
Board of Trade and Electrical Measurements	275
New Patents	276
Abstracts of Published Specifications	276

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THE ELECTRICAL TREATMENT OF WATER SEWAGE AND GARBAGE.

WHEN Faraday invented the term electrolysis to connote the decomposition of a liquid by means of an electric current, it is probable that even he, farseeing as he was, little dreamed that the "electric analysis" of water would form the starting point for the solution of the mighty problem of sewage disposal. This problem was recognised as of prime importance in the days of ancient Rome, as the ruins of the *cloaca maxima* still testify. It has baffled the "local authorities" of our most enlightened modern cities, and in spite of our knowledge of bacteriology, of zymotic diseases, and of disinfectants, it exists a standing menace, before which all our science has seemed powerless. In despair, sanitary experts have appealed to electricity, the latest of the energies existing since all time, to be harnessed to the service of man; and judging from the results already attained, and which apparently exceed those which have been achieved by more familiar means, it is reasonable to suppose that we are on the eve of a great revolution in our methods of disposing of the sewage and heterogeneous garbage which unfortunately are the inevitable concomitants of life in large towns.

The idea of rendering sewage harmless by treatment with electricity was probably born in the minds of those empiricists who will hazard anything, and who believe that electricity is going to prove a sort of universal panacea. The records of the Patent Office disclose how fatuous have been most of the proposals for dealing with this problem electrically. They illustrate the disadvantages under which those inventors labour who, being honest, and having something efficient to sell, can win no confidence from those to whom they look for commercial support. The fact therefore that there are in existence certain electrical processes for disposing of sewage which have been demonstrated to success, is all the more significant, suggestive and reassuring.

A process which is attracting the attention of all earnest sanitary reformers and of electrical engineers on the other side of the Atlantic, has been devised and demonstrated to successful issue by Mr. Albert E. Woolf, whereby not only water and liquid sewage, but solid garbage, can be treated and rendered innocuous, the agent being a purifying liquid termed "electrozone," which is obtained by electrolysing sea-water, and to which we called attention in our issue of August 25th, 1893. Sea-water contains, as is well known, varying proportions of bromides and chlorides. These substances are converted into hypochlorites and hypobromites, when the water is electrolysed, and are of such a character that they exercise a powerful oxidising action upon any organic matter with which they may be brought in contact. By mixing a sufficiency of these "hypo" compounds with impure water, perfect disinfection can obviously be brought about, whilst decaying organic refuse can be sterilised and rendered impossible as a *nidus* for disease germs.

The knowledge of these chemical effects is by no means new; it has been common property for years, and upon it have been based many antiseptic processes and treatments, both in the preservation of food, &c., and in the rendering of festering wounds aseptic, and decaying substances harmless. Nor can the production of these hypochlorites, &c., by means of electrolysis, be considered to be in any respect novel. The novelty of Mr. Woolf's process consists not in principle so much, as in application, and, it may be added, in the success which it has attained on a large scale. This is clear, from a long account of the work which is now being carried on at Riker's Island, and at Brewster's, N.Y., which appears in a recent issue of our transatlantic contemporary, the *Electrical Engineer*. [The article purports to be from the pen of one of the editors of that journal, who, while giving on the whole an intelligible account of what he saw, should not have been permitted to fall into such an error as describing a portion of the chlorine of the hypochlorite of sodium "pouncing upon" the liberated hydrogen, and producing ozone. It may be graphic writing, but it is not, as every electrician or chemist knows, a statement of fact.]

Riker's Island is the outermost of those clumps of rock, &c., which New York has reclaimed and utilised as sites for prisons, asylums, and hospitals. It is about 137 acres in extent, and for some time has been the favourite dumping ground for the garbage and filth which is daily collected by the street cleaning department of that city. The evil reek of this island could be appreciated three miles off. Our contemporary, in fact, asserts that the "fermentation went so far that at many points smoke curled up, and an egg could be cooked anywhere a few inches down." Mr. Woolf undertook the regeneration of this seething mass of corruption on June 29th last, when he ran alongside a barge on which was installed a modest electrozone plant, capable of delivering about 4,000 gallons per hour. All around the waters were black and noxious, the tides doing little to improve things, but Mr. Woolf, imitating the Bismarckian policy of frying Paris in its own juice, took that water into his tanks to be purified, and showered back upon the stinking seething mass from which it oozed. The effect appears to have been magical. Even allowing for the enthusiasm of the writer in the *Electrical Engineer*, and discounting his statements by heavy percentages, it is clear that Riker's Island, from being the abomination of desolation all a-bubble with sulphuretted hydrogen, is being rapidly converted into what the Yankees will doubtless one day dub "the sweetest spot on airth."

Measures are being taken for the establishment of a permanent installation on Riker's Island, which will consist of two boilers each of 100 H.P., a storage tank of 3,000 gallons capacity, three "Excelsior" dynamos of 1,000 ampères, at 12 volts, another for arc lighting, six electrolysing vats joined two in series, together with pumps, pipes, hose, sprayers, and other accessories. At present the plant in operation consists of two Erie City boilers of a total 100 H.P., two Payne engines of 35 H.P. each, a surface condenser of 700 feet surface, a delivering pump of 10 H.P., a distributing pump of 15 H.P., and two Excelsior plating dynamos, each of 1,000 ampères, at 12 or 13 volts. The dynamos are connected to four vats in series, each vat receiving 1,000 ampères at 5 to 6 volts, and each being of 500 gallons capacity. In each vat is a zinc-platinum couple composed of five zincs and four platinums. The zincs are an inch thick, and are 12 × 12 inches, weighing 40 lbs. The platinum electrodes weigh from 12 to 15 lbs., are 12 × 15 inches, and have a copper core, the platinum coating being 0·003 inch thick. The wear is stated to be practically insignificant.

The method of working the plant is very simple. The sea-water is pumped into the vats, is then rapidly electrolysed, the chlorides and bromides being converted into hypochlorites and hypobromites. The liquid (now termed electrozone) is then pumped out upon the island where it is received by different lines of hose from which it is sprayed upon the garbage. The plant is now running seven days a week, and 24 hours each day, and its use is paid for at the rate of $128 per daylight run and $65 per night run.

The Woolf process had been upon its trial before the Riker Island scheme was inaugurated. Last summer at Brewster's, N.Y., as we notified in the issue to which we have previously referred, electrozone was sprayed into a sewage-laden brook under the inspection of Commissioner Edson and Dr. E. A. Martin of the State Health Department, who reported very favourably upon the process, both from the chemical and bacteriological standpoints. It appeared that after the treatment, the nitrogenous matter was found to be very largely oxidised; the greater part of the free and albumenoid ammonia was transformed into nitrates, and all the nitrites were oxidised into nitrates. The bacteriological analysis showed that water containing 10,000,000 organisms per cubic centimetre was in an hour-and-a-half rendered perfectly sterile.

There appears to be plenty of independent testimony as to the regeneration of Riker's Island, and of the efficacy of the Woolf system of electrical disinfection, *e.g.*, Dr. A. L. Metz, chemist to the City of New Orleans, and to the Louisiana State Board of Health, said, after his visit to the island, July 25th :—"In every instance I found it completely disinfected. There was no active putrefaction going on, and, as a consequence, the noxious gases and odours so much complained of were not perceptible."

In conclusion, we must refer briefly to the action of electrozone in the treatment of disease; and, whilst we are naturally reluctant to countenance any attempt to put this liquid forward as a new "cure-all," and do not anticipate for one moment that the "electrozone" would do more than a dilute solution of hypochlorite or hypobromite of soda, bichloride of mercury, or, forsooth, any other well-known antiseptic that has been recognised by the Pharmacopœia, it must be admitted that some excellent results have been obtained. The *American Therapist* has reported cases of diphtheria, carbuncle, abscess, and phthisis which have been benefited by treatment with electrozone. For the present, however, we would advise Mr. Woolf not to endanger his reputation and prospects by associating himself with any venture which smacks of patent medicine or proprietary articles. There is scope enough, in all conscience, for his energies in the direction of preventing disease, without meddling with the cure of it—a matter which baffles, and seems likely to baffle, the very high priests of medicine. If Mr. Woolf will confine his attention to the purification of sewage and water, and, further, will demonstrate that what has been done on Riker's Island can be accomplished successfully anywhere else—at the mouth of the Thames, for instance, where is our own "Augean stable"—we venture to promise him, in the words of Dr. Johnson, "wealth beyond

the dreams of avarice." The disposal of street refuse, and such matters, made the fortune of many a "golden dustman," in those bad old days when men knew and cared nothing about germs and disinfectants. There are more "piles" to be made by those who will develop hygienic means of disposing of our sewage. It is evident that this is fully recognised from the numerous systems and schemes which are now being so strenuously canvassed. Altruism is admirable, but our sympathies are naturally with those who, whilst professing to succeed in solving this all-important problem, do so by means which can but increase the growing demand for electrical machinery, and enlarge the scope of electrical engineering generally. Hence Mr. Woolf, and others who may follow in his steps, or may seek to develop electrical processes, are entitled to the fullest claims upon our sympathy and good wishes.

The Voltaic Chain.

"The potential difference between a metal and a solution depends on two constants: (*a*) a constant for the metal; (*b*) the cathion concentration of the solution." This statement has been put forward and accepted as a law by many writers, but others have had their doubts about it; consequently a series of experiments has been undertaken by H. M. Goodwin in order to test its validity. The results of these experiments are described in detail in the *Zeitschrift fur Physikalische Chemie*, xiii., pp. 577—656. Two cases are considered by Goodwin, namely (1) that of a salt of the electrode, and (2) that of a sparingly soluble salt of the electrode in the presence of a soluble salt containing the same anion. The cause of the difference of potential is considered to be "the emanation of ions" from the metal into the solution until the ion pressure (p), together with the electrostatic attraction of the metal for the ions [$f(s)$], is equal to a value, P, which is constant for the metal. If the pressure, p, were originally greater than P, then the metallic ions would be deposited upon the metal until

$$p - f(s) = \text{P}.$$

In this case, of course, $f(s)$ is a repulsive force. Starting from this view and equating the change of volume energy to that of electric energy, Goodwin obtains a value for the potential difference. As in the experiments, the E.M.F. of a cell with the same electrodes in different solutions was employed, the final equation is independent of the value, P.

$$\text{E.M.F.} = \frac{\text{R T}}{\eta_\epsilon \epsilon_0} \log_\epsilon \frac{p_1}{p_2}$$

where η_ϵ is the valency of the metal, p_1 and p_2 the ion pressure, and ϵ_0 the electric equivalent of 96,450 coulombs. Goodwin then describes a number of experiments with a voltaic chain of the nature of the first case laid down for consideration—thallium, thallium chloride and potassium nitrate, thallium chloride and potassium chloride, thallium—and the observed values are shown to agree well with those calculated by means of the formula. This result was also arrived at when the salts of other metals were substituted for those of potassium. In discussing the second case which he laid down, Goodwin opposed two chains of zinc, zincic chloride, mercurous chloride, mercury with varying concentrations. The observed and the calculated values on being compared were found to be in accord. Further, a number of changes were made which, by theory, should have no effect on the E.M.F., such as the substitution of bromides for chlorides, of silver and silver chloride for mercury and mercurous chloride, &c., and in each case the results were in accord with the predictions. Hence it is concluded that the law which these experiments were designed to test is valid.

The Purification of Zinc by Electricity.

It seems odd to refer to silver or gold as an "impurity," for the word connotes something which one should be anxious to get rid of, and this is rank heterodoxy, judging from the attitude of most people in regard to the precious metals. Nevertheless, strictly speaking, gold and silver in conjunction often with antimony, arsenic, copper, &c., occurring in commercial zinc are nothing more nor less than impurities, and for many purposes it would be desirable to eliminate them and turn them to good account. This is the object of an ingenious process which has been devised by P. C. Choate. Briefly and essentially, the process consists in volatilising the zinc as fume by heating its ores with a reducing agent in a furnace in the presence of air. This fume is re-heated with carbon at a moderate temperature, so as to drive off any metallic constituents which are more volatile than zinc. It is finally reduced, distilled, and cast into pieces of suitable form to be used as anodes. These are immersed in a solution of zinc sulphate containing a little soluble chloride. The cathodes are plates of zinc or copper. On passing a current of electricity pure zinc is deposited, whilst any antimony, arsenic, copper, silver, gold, &c., that may be present will be separated and will settle in the bath. It is believed that the previous metals thus eliminated may be susceptible of recovery and of subsequent commercial use.

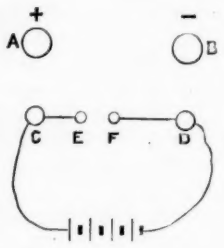
Magnetic Shielding.

The paper which Prof. Rücker, F.R.S., read last November before the Physical Society, upon "The Magnetic Shielding of Concentric Spherical Shells," is given at length in their *Proceedings* (Vol. xii., Part iv.). The author brings forward a number of facts of practical importance where magnetic apparatus is required to be protected, and points out the two devices which may be employed to effect this purpose, *i.e.* (1) the case in which external space is protected against magnetic forces produced within the enclosure, and (2) the converse system whereby instruments are jacketed with iron and thus protected against external magnetic influence. In the earlier part of the paper the general theory is developed, chiefly for the sake of defining the notation used, this implies some recapitulation from Maxwell; the main discussion is, however, concerned with the question of the "best conditions" for shielding, and this is entirely new ground. The process of shielding by lamination is illustrated by the hydro-dynamic analogue to the magnetic field. Supposing sources and sinks of equal power to be placed within an enclosure, we may weaken the flow outside either by making the enclosure, or part of it, very permeable; or by making the bounding surface very impermeable. Similarly in the magnetic problem there are two ways of reducing the internal field, viz., by enclosing the central region by shells of greater, or by shells of less, permeability than the surrounding space. Although we cannot in practice use any material of less permeability than the air, we can introduce into an iron shell layers of material less permeable than itself. These may tend to reduce the external field by preventing, as it were, the force from penetrating to the external shell. This analogy long suggested that laminated shells, in which both the permeability of the iron and the relative impermeability of other materials are utilised, may be the most effective shields; and the author proceeds to enquire which is the best arrangement that can be made under specified conditions as to the magnitude of the space at disposal, or as to the weight of the shielding material used. The second problem, to the result of which attention is drawn, is that which defines the relation between the shielding exerted by a number of concentric shells: (1) on external space when the magnetic forces are produced within the shells; and (2) on the enclosed space when the magnetic forces are produced outside. The investigation is limited (*a*) to concentric shells; (*b*) to cases in which the equipotential surfaces are surfaces of revolution about a line through the common centre of the cells; and (*c*) to the case in which the permeability of each shell is constant.

A METHOD OF PRODUCING AN ELECTRIC ARC.

In a recent issue of *L'Electricien* the following interesting method of producing an electric arc is given by M. Belloc. If opposite to the poles, A B, of a Holtz or Wimshurst static machine, is placed a Mascart exciter, C E, F D, a spark will flash between A and C, E and F, D and B. Now if the two branches of the exciter are put into communication with the poles of a battery, P, it will always be possible with a machine of sufficient power to produce the passage of the spark at the same points, and an arc will be formed between E and F.

The distance, E F, for which the phenomenon is produced, will depend upon:—1. The nature of the poles of the battery compared with those of the machine. 2. The nature of the electrodes, E and F. 3. The difference of potential of the battery. 4. The output of the machine.



The maximum value of E F for a battery having a difference of potential of 50 volts was found to be as follows:—

Nature of electrodes.	Poles of same kind.	Poles of opposite kind.
Carbon	0·5 mm.	1·0 mm.
Copper	1·0 „	3·0 „
Zinc	1·5 „	3·5 „
Copper-zinc	—	3·5 „

The distance is considerably reduced when C is negative or D is positive; and these conditions being satisfied with electrodes of opposite kind, the maximum effect is obtained. The arc is not produced when the machine has no condenser, or when this is replaced by a Rhumkorff coil. In the case of the Holtz machine, with four plates, the distance, E F, is capable of being extended to 7 or 8 mm. if zinc be used, but the arc is not a true one. When alternating currents are employed, the distance is reduced whilst the arc is replaced by a series of flashes. The experiment succeeds well in the case of a Ramsden machine. In conclusion, Belloc points out that it is possible to light up an electric arc as one lights a gas jet, by means of a spark from a static machine.

ELECTRIC LIGHTING INSTALLATION AT THE BOMBAY GOVERNMENT DOCKYARD.

There are in India a number of extensive electric light installations, and a description of one of these we consider will greatly interest our readers, as not much has hitherto been published regarding installations in that part of the world.

It is now just over 18 months since the installation for lighting the Indian Government Dockyard at Bombay commenced working. The accumulator system has been adopted, and it possesses several features of interest, and information of a very satisfactory nature is afforded by it of the practical working of the system in India. Duplicate parts are provided wherever necessary, and the whole plant is of exceptionally good quality. The acting director of the Indian Marine, Bombay, and Mr. H. Gill, the electrician in charge of the installation, have afforded an Indian contemporary, to which we are indebted for these particulars, full information of the work.

There are two dynamos of the inverted horse-shoe type of field magnets, designed to give continuous currents. They were supplied by Messrs. Siemens Bros. & Co. They are fitted with drum armatures. The field magnets are separated from the cast-iron base by intervening brass supports, to avoid a short circuit and consequent leakage of magnetism through the base. They are compound wound machines operating both arc and incandescent lamps; in each the shunt coil is wound on both the limbs; the series coil, which is externally placed, being wound on one limb only. One end of either coil is attached to the same terminal, of which there are three on each dynamo, close to the massive cast-iron yoke at the top, so that the series coil may be short-circuited during the charging of the battery; the dynamo is thus used as a shunt machine during this operation. The body of the dynamo is cast in a separate piece from the base so that the former can slide on the latter, to regulate the tension of the belt. The commutator is of the usual insulated copper bar type, four stiff wire-brushes collecting the current from these. The dynamo is capable of giving an output of 211 ampères, at 125 volts at its own terminals, the number of revolutions of the armature being 600 per minute. The two dynamos are used alternately.

Provision has been made to secure the dynamo from the effects of the back-electromotive force of the accumulator cells, which would reverse its polarity and run it as a motor, should by chance the proper terminals not be used to connect it with the battery of accumulator cells. This is effected by the insertion in the circuit of an Elwell-Parker automatic cut-out wound for 80 volts and 120 ampères.

The motive power for the dynamo is supplied by a steam engine of 30 H.P. nominal, by Messrs. Marshall, Sons & Co., Gainsborough, which is run at a speed of 120 revolutions per minute to charge the battery, and 140 revolutions per minute when supplying current directly to the lamps. It is fitted with Proel's patent expansion valves and Corliss exhaust valves. The dynamo is driven by means of Tullis's patent leather link belting.

The battery being usually charged in two sections, in parallel, there is an ammeter for each circuit, on the same switchboard, each operated by its own sliding switch. Fuses, fixed on the same board, and covered by ebonite caps which can be screwed on, are interposed in the dynamo-battery circuit.

Between the accumulator switchboard, and the switchboard for the lights, a large double-pole sliding switch enables either of the dynamos to be introduced into the circuit, according as one or the other is proposed to be used. A noteworthy feature of this and the other switches, is the provision of Siemens patent carbon contacts with each.

On a second switchboard are fixed the ampère and voltmeters to measure the strength and the potential difference on the mains supplying the current from the accumulator battery to the lights. Switches for the arc and incandescent light circuits, arranged in parallel, and safety fuses of white metal for each circuit, covered over with ebonite caps, are fixed on the same board. In addition, there are a two-way switch to connect up the accumulator cells either in series or in parallel, and a special switch for five extra cells used as a reserve with the battery.

The accumulator cells are 64 in number, and were supplied by the Electric Power Storage Company. Five extra cells are provided with the battery, to increase the potential difference by a little over 10 volts when necessary, as well as to replace any cells which may have been temporarily placed on the "sick list." The accumulator battery is charged every alternate day, and can store a little over two nights' charge of 10 hours each. The battery is accordingly never completely run out, nor is the discharge rate allowed to become too high, so that two of the most fertile sources of trouble in an accumulator cell are carefully avoided.

The installation being arranged to work at a pressure of 125 volts, the 64 cells in the battery, with a potential difference at the terminals of each of a little over 2 volts, would maintain a total potential difference at the terminals of the battery of somewhat over $2 \times 64 = 128$ volts. As the farthest light is about a quarter of a mile distant from the battery, assuming that the drop has been so regulated that the voltage at a middle point of the installation should be exactly the full required amount (= 125 volts), the potential difference at the terminals of the farthest lamp cannot be much below 122 volts. The five extra cells are excluded from this calculation.

An additional provision has been made against the deterioration of the accumulator battery, by the insertion in the circuit, between the battery and the lamp circuits, of an automatic alarm, which rings an electric bell, when the discharge rate of the battery exceeds a certain fixed amount.

The battery supplies current to both arc and incandescent lamps. Siemens's arc lamps are used, fitted with a copper ribbon in each to regulate the feed of the carbons, which burn for 12 hours; they give 3,000 candle-power each. There is one arc lamp by the same makers, constructed to give a light of 7,000 candles. The same type of lamp as is used here is also in vogue at the Royal Albert Docks, London. As the voltage in the mains is much higher than is required for arc lamps, the former are grouped into series sets of two each; hence there are nine arc light circuits, with just as many fuses and switches.

Choking coils, made of bare German silver wire, mounted on frames fixed against the wall in the dynamo and engine-room, are included in each arc light circuit, a double coil being provided for the largest arc lamp.

The incandescent lamps, which were supplied by Messrs. Siemens & Halske, number about five to six hundred in all and are of 16 and 32-candle-power.

Portable lamps, with brass protecting cages, are used in the workshops. Each is provided with about 12 feet of India-rubber coated wires, fixed into a special terminal piece, which can be screwed into a brass socket, fixed on wooden boards against the wall, &c. The sockets are covered by a brass cap when not in use.

India-rubber insulation is used for interior work. Conductors suspended in the open air are bare. Teakwood casing is used in the former case.

The lamps are provided with their own switches, so that there is absolutely no interference with the dynamo room during the night. Accordingly, to ascertain the power expended during a night, a permanent and continuous record of the same is obtained by means of Richard Frére's self-recording ampère and voltmeters.

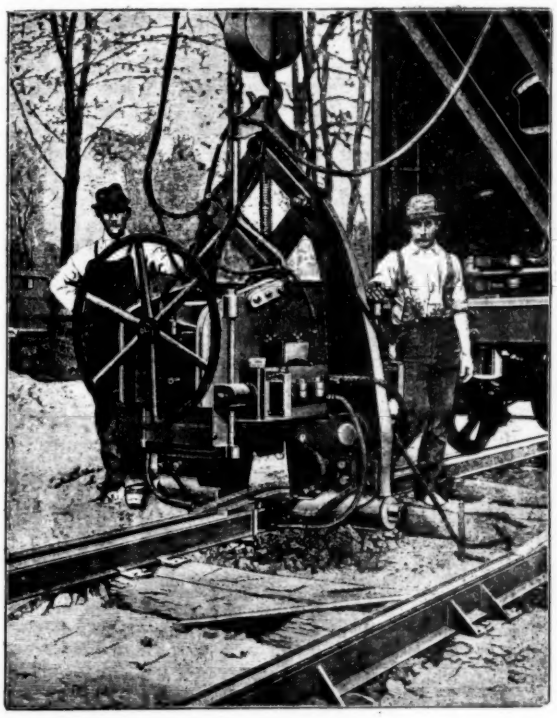
There have been practically no breakdowns or repairs. Considering the discharge rate from the cells, and the efficiency with which every part of the installation continues to work, this complete installation on the accumulator system, the only one of its magnitude in Bombay, may so far be pronounced a complete success. As a battery of accumulator cells requires skilled attention more than other systems of electric illumination, the satisfactory results afforded are stated to be almost wholly attributable to the excellent supervision of the electrician in charge of the installation.

THE ELECTRIC WELDING OF RAIL JOINTS.

For many years the belief has obtained among engineers that in laying railroad tracks it is necessary to leave a certain space, about one-sixteenth of an inch, between the ends of the rails, in order to provide for expansion and contraction due to the changes of temperature. On the advent of electric welding, says the *Scientific American*, a very obvious application of it seemed to lie in the welding of rail joints, if the assumed trouble in regard to expansion and contraction could be got rid of. Various experiments went to show that this necessity was rather of the nature of a myth. The Johnson Company, of Johnstown, Pa., which proposed to apply electric welding to rail joints, tried an experiment to test the question. They firmly riveted, with long fish joints, 1,500 feet of track, so that it was practically continuous, the rivets being turned to fit the holes accurately. No trouble was experienced, the 1,500 feet of track not changing in any way. Other experiments have been made in the same direction, going to show that there is no danger to tracks incident to tight joints.

The electric street car companies have shown a disposition to adopt welded joints, not only to secure a continuity of track for mechanical reasons, but for electrical ones also. As the track is used for the return current, it is obvious that its conductivity should be as high as possible, and such conductivity is evidently favoured by welding the joints together.

We illustrate in our present issue one form of the welding machine used by the Johnson Company. It consists of a Thomson welding machine of special construction, arranged to be carried on a crane projecting from a construction car. Looking at the cut, there will be seen two pivoted levers working in a vertical plane transverse to the track. Between them lies the induction coil, while above is a toggle joint operated by the large wheel in front, by which the ends of the levers can be pressed together or separated with considerable power.



In welding a joint the current is not passed from rail to rail, but is passed transversely to the two rails. For each joint four lugs are used; these are short pieces of iron, fitting pretty closely to the sides of the web of the rail, and also extending around part of its head and the upper part of its flange. When a joint is to be welded, the construction car is advanced, and a small emery wheel driven by a flexible shaft is first applied to the sides of the rails in order to brighten them. The two lower lugs, resting on the lower flange of the rail, and extending half way up the webb, are put in position, the jaws of the electric welder are placed upon the lugs, and the current is turned on. The dark red colour due to the heat appears almost instantly, and keeps brightening until a full white heat is reached. At this point one of the workmen suddenly turns the wheel, closing the toggle joints, and squeezing the lugs against the sides of the rails. This not only welds them to the rails, but it is supposed to force some of the metal between the ends, so as to make a true butt joint. Gun metal clamps keep the rails in alignment during the operation. As soon as the lower lugs are welded, the upper pair are put in position, and practically fill the remaining gap, the current is passed through them, they are squeezed home when white hot, and the joint is complete.

The operation is so perfect, that after the welding is done and the ground is filled to its level, it is almost impossible to tell where the weld has been completed. In closing the joints every third joint is left unwelded, in order to allow for the expansion due to the changes of temperature incident to the operation. Afterward the line is gone over a second time, and the missing joints are welded. All of this is in the direction of reducing the resistance of the rails, and of so providing a better path for the return current. Whether it will do away with electrolysis or not may be considered an open question.

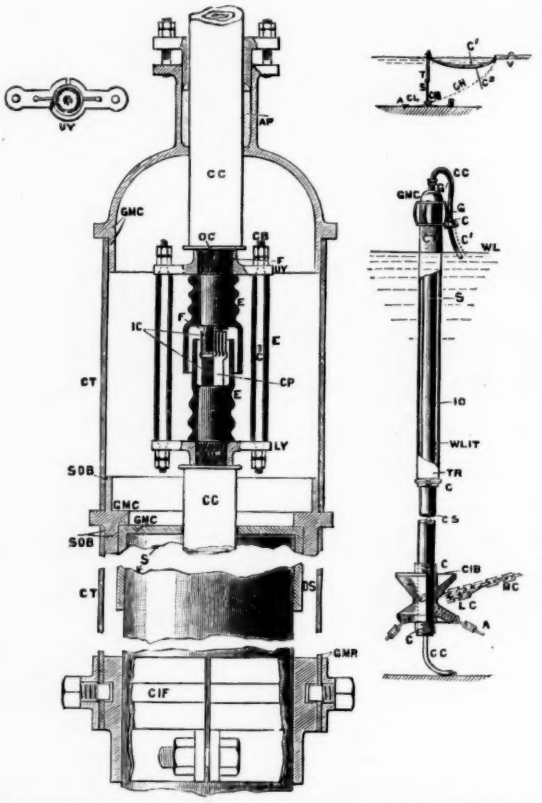
The process illustrated has already been successfully applied in Boston, St. Louis, and Brooklyn, and bids fair to have an extensive application on trolley roads especially. The coming winter will put many miles of track to a severe test, which there is every reason to believe they will stand perfectly.

Our contemporary acknowledges its indebtedness to the *Street Railway Review* for the photograph from which the engraving was made.

SHIP TO SHORE COMMUNICATION.

To put ourselves in telephonic communication with our light ships has involved the display of no inconsiderable ingenuity, but to transmit electrically a force of, say, 200 horse-power from a vessel intended to ride out any weather, and free to swing with the tide, is a still more difficult problem.

With a view to solving such a problem, Mr. C. Scott Snell has designed the arrangement we illustrate, and it will be seen this consists of a wooden spar buoy, which, having been sawn down longitudinally, is hollowed out to take a concentric cable, and bound together again. The lower end of the spar is fitted with a cast-iron boss, to which the anchors, three in number, are attached, and around the body of this boss is fastened the main chain cable from the vessel (in the form of a loop), thereby admitting of free rotation of the ship around this centre.



U Y, Upper yoke; F, Ferrule; A P, Air tight packing; C C, Concentric cable; O C, Outer conductor; G M C, Gun metal casting; C B, Copper bars; E, Ebonite; C^2, Copper; C F, Connected piece sweated to conductor; L Y, Lower yoke; I C, Inner conductor; C T, Copper tube; S O B, Sweated or brazed; S, Spar non-rotating; O S, Oil space; G M R, Gun metal ring; C I F, Channel in fixed clamp for G M bolts to run in; C, Clamp; C^1, Carrier; G, Guards; G^1, Gland; W L, Water level; I O, Insulating oil; W L I T, Water level in tube; T R, Tube and ring free to turn round clamp; C S, Cable in spar; C I B, Cast-iron boss; M C, Main cable to vessel; L C, Loop of chain allowing vessel to run around spar; A and B, To single fluke anchors; T, Tube free to rotate; C L, Chain loop; C H, Chain cable; C^3, Conductor; V, Vessel.

The spar cannot rotate, though it is free to oscillate in any direction, and at its upper end it terminates in a cap, through which projects the cable, this being suitably bared to admit of the rigid mechanical and electrical attachment of the connecting frame shown, the frame being thoroughly insulated.

The upper end of this connecting frame is so formed as to grasp the continuation of the concentric cable which leads to the vessel, and which rotates therewith. The bared portions of this cable are fitted with ferrules to allow of smooth rotation in the frame.

It will be seen that this cable to the ship passes through a stuffing box, in a kind of helmet, which rotates on the shoulders of the spar cap, and is fitted with a tubular extension enveloping the spar. At the extreme lower end of this tube is a fitting which prevents the tube lifting, although it may freely rotate.

Providing, therefore, the stuffing box is air-tight (and by the use of melted pitch or other suitable compound this ought to be easily attainable), the air in the annular space between spar and tube will displace the water and keep a dry joint; but to make "assurance doubly sure," the inventor inserts oil, until it reaches to the shoulders or cap of the spar, and, forcing the water downwards, practically ejects it entirely. As the tube may extend downwards for 20 feet, it will be seen that the joint is as safely protected from salt water as if it were on dry land, and easy rotation is ensured by the lubricating property of the oil. It is not absolutely necessary for the spar to project above the water as shown.

As the object of transmitting such a current of electricity ashore may be somewhat puzzling, we may mention that it is in connection with a wave motor also designed by Mr. Scott Snell, particulars of which are not at present available for publication, but which we hope to be able to give in some future issue.

We understand that the Callender Bitumen and Telegraph Company, of 101, Leadenhall Street, will shortly make a trial of this apparatus. If successful, it may be said to open up the question of electrically lighting lightships from a generating plant on shore.

REACTANCE.*

By CHARLES PROTEUS STEINMETZ and FREDERICK BEDELL.

The term "reactance," which has been used and advocated by the writers and others, and which has been officially adopted at our suggestion by the American Institute of Electrical Engineers at its Philadelphia meeting, is one which assumes particular importance now that the term "inductance" is defined as synonymous with the "coefficient of self-induction," usually symbolised by the letter "L." Reactance is a quantity similar in many respects to resistance. but the electromotive force in overcoming reactance consumes no power, for it is at right angles to the current.

The impressed electromotive force in an alternating current circuit may be divided into two components: First, the *power electromotive force* in the direction of the current, and, second, the *reactive electromotive force* in quadrature with the current to overcome the reactance. The reactive electromotive force is the product of the current and the reactance. *The reactance is, accordingly, equal to the component of the impressed electromotive force at right angles to the current, divided by the current.* Reactance is measured in ohms.

The reactive electromotive force in the circuit may be due to self or mutual induction, to capacity, or to some outside counter electromotive force produced by a motor or other device. In general, in any alternating current circuit,

$$\text{Impressed E.M.F.} = \sqrt{(\text{Power E.M.F.})^2 + (\text{Reactive E.M.F.})^2};$$

that is, the impressed electromotive force is the vector sum of the electromotive force which transmits power and the reactive electromotive force.

Reactance tends to cause a phase difference between current and electromotive force. If θ represents this angle of phase, we have the relation,

$$\tan\theta = -\frac{\text{reactance}}{\text{resistance}}.$$

When θ is negative, the current lags behind the electromotive force; when θ is positive, the current is in advance of the electromotive force. The expression for the instantaneous value of the current may be written,

$$i = I \sin(\omega t + \theta).$$

or

$$i = \frac{\text{Impressed E.M.F.}}{\text{Impedance}} \sin\left\{\omega t - \text{arc tan}\frac{\text{reactance}}{\text{resistance}}\right\}.$$

A few illustrations of particular cases will make the use of the term reactance more clear.

Circuits Containing Resistance and Inductance.—In a simple circuit containing resistance and inductance, the resistance is equal to $L\omega$; that is, it is 2π times the product of the inductance and frequency. The impedance being the vector sum of the resistance and reactance, is

* A paper presented at the close of the Philadelphia meeting of the American Institute of Electrical Engineers, 1894.

$$\text{Impedance} = \sqrt{R^2 + L^2 \omega^2},$$

where $\omega = 2 \pi \times$ frequency. In this case all the power is used in overcoming resistance, and the power electromotive force is equal to the ohmic electromotive force R I. The reactive electromotive force is equal to the inductive electromotive force L ω I; hence

Impressed E.M.F.

$$= \sqrt{(\text{Power E.M.F.})^2 + (\text{Reactive E.M.F.})^2};$$

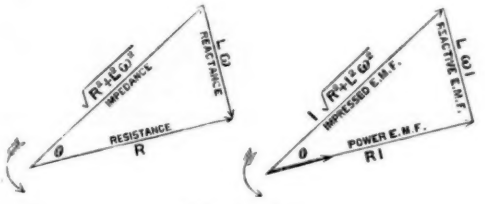
or

Impressed E.M.F.

$$= \sqrt{\text{Ohmic E.M.F.}^2 + \text{Inductive E.M.F.}^2}.$$

The impressed electromotive force in this case is the vector sum of the electromotive forces necessary to overcome resistance and inductance.

A consideration of figs. 1 and 2 (in which positive



Figs. 1 and 2.

direction is counter clockwise), will show that the reactance and reactive electromotive force are *positive* in the case of a circuit containing inductance. The impressed electromotive force, which is the sum of the two, is therefore in advance of the current, which is in the same direction as the power or ohmic electromotive force. The current is indicated by a closed arrow in the figures. The same, however, may be otherwise expressed if we take the impressed electromotive force as our direction of reference, by saying that the *current lags behind* the electromotive force by the angle θ, which angle is negative, therefore, for circuits with inductance according to the relation

$$\tan \theta = - \frac{\text{reactance}}{\text{resistance}} = - \frac{L \omega}{R}.$$

The value of the current at any instant is given by the equation

$$i = \frac{E}{\sqrt{R^2 + L^2 \omega^2}} \sin \left(\omega t - \text{arc tan} \frac{L \omega}{R} \right).$$

Circuits Containing Resistance and Capacity.—In such circuits the reactance is equal to $- \frac{1}{C \omega}$, where C, capacity, and $\omega = 2 \pi \times$ frequency, that is, it is negative. The reactive electromotive force is also negative, being equal to $- \frac{I}{C \omega}$. This negative reactance gives a positive value to the angle θ, and the current is accordingly in advance of the electromotive force. We have then

$$\text{Impedance} = \sqrt{R^2 + \frac{1}{C^2 \omega^2}},$$

and

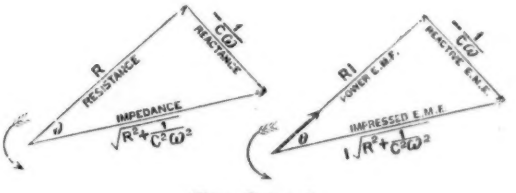
$$\tan \theta = - \frac{\text{reactance}}{\text{resistance}} = + \frac{1}{C R \omega},$$

similar to the corresponding equations above. The instantaneous value of the current is given by the equation

$$i = \frac{E}{\sqrt{R^2 + \frac{1}{C^2 \omega^2}}} \sin \left(\omega t + \text{arc tan} \frac{1}{C R \omega} \right).$$

These relations are shown in figs. 3 and 4.

Circuits Containing Resistance, Inductance, and Capacity.—In a circuit containing inductance and capacity the reactive electromotive force is the sum of the inductive electromotive force, and the condenser electromotive force; that is, L ω I $- \frac{I}{C \omega}$. The reactance is similarly the sum of two terms, L $\omega - \frac{1}{C \omega}$; thus, the reactance is positive or negative, according to whether the inductive electromotive force is greater or less than the condenser electromotive force.



Figs. 3 and 4.

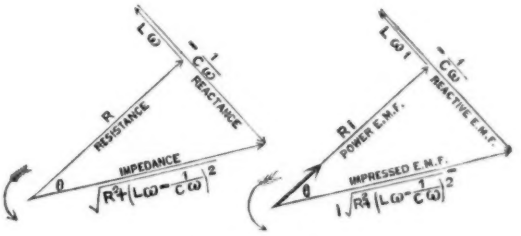
Whether the current is behind or ahead of the impressed electromotive force depends upon the same condition, for

$$\tan \theta = - \frac{\text{reactance}}{\text{resistance}} = \frac{1}{C R \omega} - \frac{L \omega}{R}.$$

The value of the current at any instant is

$$i = \frac{E}{\sqrt{R^2 + \left(L \omega - \frac{1}{C \omega} \right)^2}} \sin \left\{ \omega t + \text{arc tan} \left(\frac{1}{C R \omega} - \frac{L \omega}{R} \right). \right\}$$

The diagrams in figs. 5 and 6 illustrate the case of a single circuit containing resistance, inductance and capacity.



Figs. 5 and 6.

In the case here represented, the condenser electromotive force is greater than the inductive electromotive force, and the current is therefore in advance.

Circuits Containing Mutual Induction.—To further exemplify the use of the term reactance, let us consider a circuit containing a transformer. Besides the electromotive forces already discussed, we must consider the back electromotive force due to the influence of the secondary upon the primary circuit. This may be resolved into two components, one in the same direction as the current, and the other in quadrature with it, which will form part of the power electromotive and reactive electromotive forces, respectively. The electromotive force introduced by a motor is treated in the same way.

These illustrations will suffice to show the method by which any electromotive force in a circuit is resolved into two components, one in the direction of the current, which therefore transmits power, and the other at right angles to the current, which represents no power but simply overcomes the reactance.

It is to be borne in mind that the terms here given may be used in all alternating current circuits, whether the current is harmonic or not; for, when the current is not strictly harmonic, we may consider it equivalent to an harmonic current. The *equivalent* harmonic current and equivalent harmonic electromotive force have the same square root of mean square values as the actual current and electromotive force, and have such relative phase positions that the same power is transmitted.

TRANSFORMER SUB-STATIONS AND NETWORKS.

A CONTEMPORARY publishes an article on this subject under a heading which suggests that the treatment is "up-to-date," and also that up-to-date methods and appliances are described.

The combined high tension feeding and low tension distributing system is the one chosen for description; we say description advisedly, for no attempt is made to discuss its advantages or to prove its superiority over the other systems farther than to enumerate and claim many advantages for a method in which two or more high pressure networks are used, with automatic switches for switching out transformers and secondary mains. This may be quite up-to-date, but its practicability has yet to be demonstrated, and instead of a discussion of up-to-date practice, we find nothing more than a bald description and weak advocacy of a complicated and expensive system of mains, such as can be found in proposals made repeatedly by many designers during the past four or five years, and quite recently in our own pages.

No discussion of such schemes can be considered as complete, or, in fact, useful, unless they start with the proposition that the high pressure is employed to save in first costs.

To expect us to take for granted that all these systems effect this object, is too large an order on our credulity; in many cases it is probable that the money expended on high pressure insulation, copper mains, switches, transformers, transformer chambers, and all other outlays inherent to high pressure being introduced, would more than cover the cost of additional copper required to work with a simple low pressure network only.

The advocates of high pressure have had to climb down considerably of late years, and admit that the low pressure distribution network is a necessity, the high pressure playing a subordinate part in saving copper in the feeders only, and that, too, at the expense of high insulation, danger, and transformers; for to warrant the use of high pressure it must save in the feeders as much money as shall purchase the higher insulation, the transformers, and all the expenses of their housing and attendance, and show a balance on the right side.

As already pointed out in the ELECTRICAL REVIEW, there are cases where a distant station supplies centres widely apart, wherein high pressure is a self-evident necessity; the Niagara falls and the Deptford schemes being cases in point.

But in the comparatively minute systems laid down in most towns in this country, the necessity for the elaborate and expensive high pressure plant is not so obvious, and requires demonstration.

There is no end to the piling on of complications; some engineers seem to treat transformers as if it were a positive advantage to transform current before delivering it, and not content with one high pressure network they propose to use a number, followed up by introducing automatic switches and other complications. And all for what? To save copper in the feeders and distributors. This is effected, but at what cost? That is the question.

In some cases, such as the City of London lighting, and the other larger schemes referred to, the cost is trifling compared with the saving; but in the miniature plants laid down in provincial towns on the same system, the cost most probably far overbalances the savings effected by the use of high pressure in connection with a low pressure network.

The advocates of these so-called up-to-date plans forget that the cost of electrical energy to the consumer is at present the burning question, and that the interest on expenditure on feeders and distributors and their maintenance is a large charge on the costs, and that the losses in dynamos, engines, and boilers, is a small item compared with the losses in distribution.

The question of using low or high pressure, or a combination of the two, is one of the up-to-date subjects of the hour; the article to which we refer touches only upon one phase of it, and that without advancing the question any nearer a general solution.

There is nothing up-to-date about the three methods of arranging transformers. 1. In large banks in a few sub-stations, for that was done by Siemens, and described in a patent of 1885; the second method is a simple modification of the first, and is quite as ancient; the third method was patented in 1886 by the officials of the Westinghouse Company, and yet the description of these three methods forms the bulk of the article.

THE MAXIMUM AND EFFECTIVE PRESSURE OF ALTERNATING CURRENTS.

IN our last issue we referred to the statement made by Prof. Thompson that alternating currents caused less trouble from leaks than if a continuous current of the same voltage were employed. We then pointed out how little this theory was in accordance with the experience of telegraph engineers, and stated that for breaking down faults it is the reversed or alternated current that is employed. There is, however, another point which we can mention as bearing on the same subject, and it is a no less important one. If "same voltage" be held to mean "effective voltage," and it would be useless to talk of voltage for lighting purposes were anything else to be referred to, then our contention is very simple. The pressure which corresponds to the voltage of a continuous current doing the same work is obtained by taking the square root of the mean square of the alternating pressure. This is, of course, an elementary fact known to every first year student, but it seems to have slipped past Prof. Thompson. Now the stressing pressure to which the cable is subjected is not this value, but the maximum value of the pressure as shown by the greatest ordinate of the sine or sawtooth curve of volts given by any particular machine; so that the cable working under the latter conditions is stressed to a greater extent than is represented by the virtual voltage under which the current flows through it. The effective pressure is proportional to the square root of the mean square of the instantaneous values of the impressed E.M.F., which varies harmonically with the time, and this value is equal to 0·707 of the maximum reached during either half period of a complete alternation. If the amplitude of the harmonic motion be a, then the square root of the mean square is represented by $\frac{a}{\sqrt{2}}$, and this is the value of the voltage which is indicated by a voltmeter or by the lamps supplied from a circuit without transformation. The cable insulation must, however, be designed to withstand a stress of a volts, and not $\frac{a}{\sqrt{2}}$ volts, whereas the same cable would, for a continuous current of the same virtual voltage, only require to be insulated for 0·707 a volts. So well is this known that cable manufacturers, who submit their cables to a "stressing test" before sending them out to clients, only run the pressure up to 1,600 volts virtual for a cable, the specification of which requires a test to be applied of 2,000 volts if the cable is to be used for 1,000 volts continuous current in service. Of course, tests are nearly always made with transformed alternating currents; very few firms would care to keep a set of c.c. transformers or a huge battery of secondary cells to apply stressing tests by a continuous current. Another example of this recently came to our knowledge. A Thomson electrostatic voltmeter was ordered from a well-known maker, "to read up to 20,000 volts." On testing the instrument on high tension transformers the alternating current sparked across from needle to quadrants at 18,000 volts virtual. On this being pointed out to the makers they replied that it was capable of reading up to 20,000 volts, *i.e.*, up to a maximum voltage of that value. Of course it could be fairly argued that no means in common use exist for obtaining such a c.c. voltage with any energy behind it, but, at the same time, the contention necessarily held good. The instrument read $\frac{20{,}000}{\sqrt{2}}$ volts perfectly easily, and would have read up to 20,000 volts continuous. As it was, it could not be used above 16,000 volts virtual alternating, as when this pressure was applied to its terminals a maximum stress of 20,000 volts was applied to

the dielectric—air—which was the sole insulator between the needle and quadrants. This is a point which has never been brought out as prominently as it deserves, and we think that it would be well if in future there should be no ambiguity on the matter.

THE "HERMITE" HIGH TENSION ELECTROLYSER FOR ELECTROLYSING SEA-WATER.

The accompanying illustrations show the details and method of working of an electrolyser designed to meet the requirements of places where a direct electric current of 50 or 100

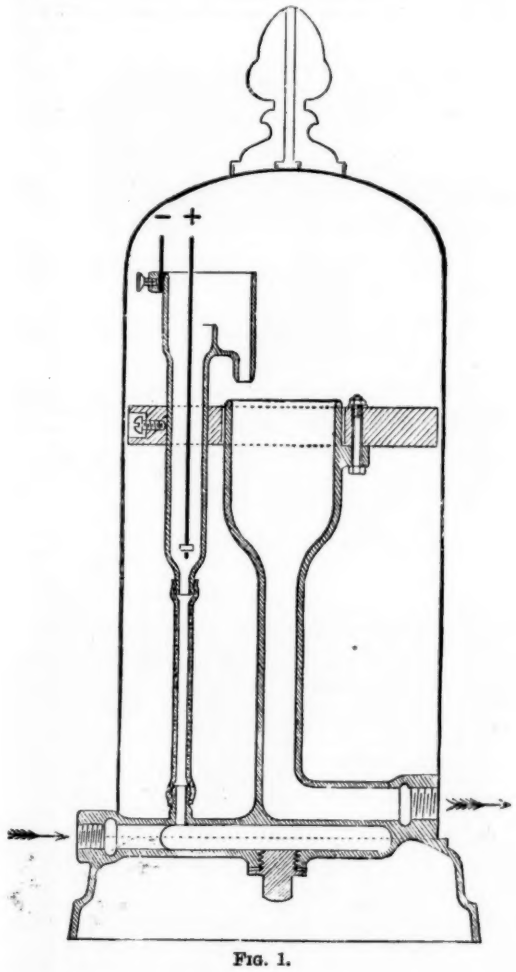


Fig. 1.

volts is available, whether from a public supply, or from a private electric light installation.

We have before referred to the Hermite process for deodorising and sterilising sewage, and to the demonstrations made by the inventor at Havre, Brest, Worthing &c., with a view to its adoption on a large scale for supplying a powerful and cheap antiseptic, and laying it on in the streets of a town for flushing closets and disinfecting drains. The conclusion forced itself upon us that whether it could be economically applied on the scale recommended by M. Hermite or not, not a shadow of doubt existed that an antiseptic solution so powerful had many applications for the sanitation of hospitals, steamers, and buildings where present sanitary arrangements are made greater to provide immunity from peril.

So that such cases might be dealt with without waiting for a municipal supply of the electrolysed sea-water or saline solution, an electrolyser capable of being worked from an ordinary direct current of 100 volts, or less, has been designed and can be seen in operation at the offices of Messrs. Paterson & Cooper.

It consists of a series of galvanised iron tubes, which form the negative poles of the electrolyser. These tubes are separated by rubber tubing from a galvanised iron chamber common to all. The positive electrodes are of platinum. Connection is made between a supply tank of sea water, or of a solution of salt and magnesium chloride. The sea water

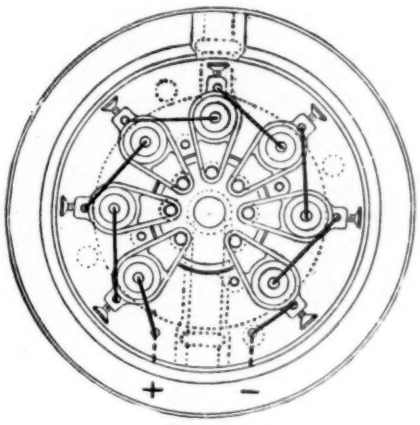


Fig. 2.

enters the chamber and rises in the tubes, and the current being turned on becomes electrolysed to a sufficient degree. It then overflows into the central pipe, from whence it makes its exit into the flushing cistern of the closet, or can be drawn off and carried away and used for any purpose of disinfection which the consumer may have in view.

The positive and negative electrodes are connected in series, and a current of about 15 ampères is made use of. Figs. 1 and 2 will explain the principle of the arrangement where the preceding description is not sufficiently clear. The apparatus is made in two sizes, one with seven and the other with 14 tubes.

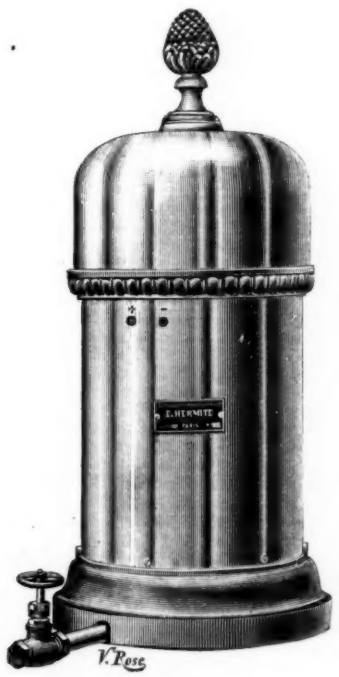


Fig. 3.

A series of tests have given a production of ·8 grammes per ampère hour in each tube. With the larger electrolyser it therefore follows that one hour's working will produce 80 gallons of solution at ·5 per litre of chlorine strength, which strength is far more than sufficient for the destruction of any pathogenic micro-organisms.

The apparatus is fitted with a handsome enamelled zinc cover (fig. 3) so that its appearance does no discredit to the most elaborately fitted lavatory.

Fig. 4 shows the arrangement when used for automatically flushing a closet. The chain when pulled down for flushing the pan completes the electric circuit by a locking switch. The ball cock falls and the levers attached to it open the valves, allowing a fresh lot of sea water to flow from the supply tank, *a*, through the electrolyser into the flushing tank, *c*. When the tank is full, the ball-cock in rising closes the valves and turns off the switch.

Fig. 5 shows the application of the process for flushing urinals.

The cost of current used in producing 80 gallons of disinfectant, at half a gramme chlorine per litre, can easily be calculated, and will be found to be 1s., at the rate of 8d. per unit, or 6d. if the usual reduced charge for day load is taken.

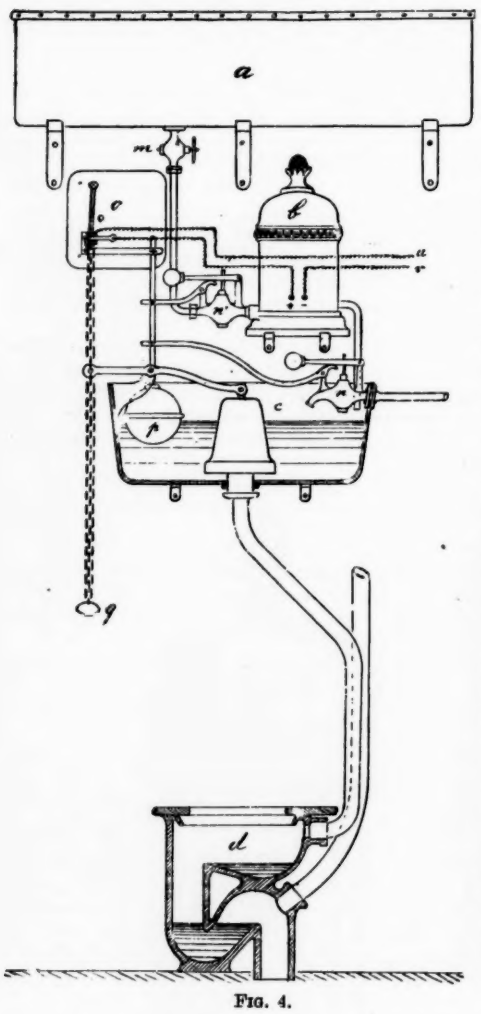


Fig. 4.

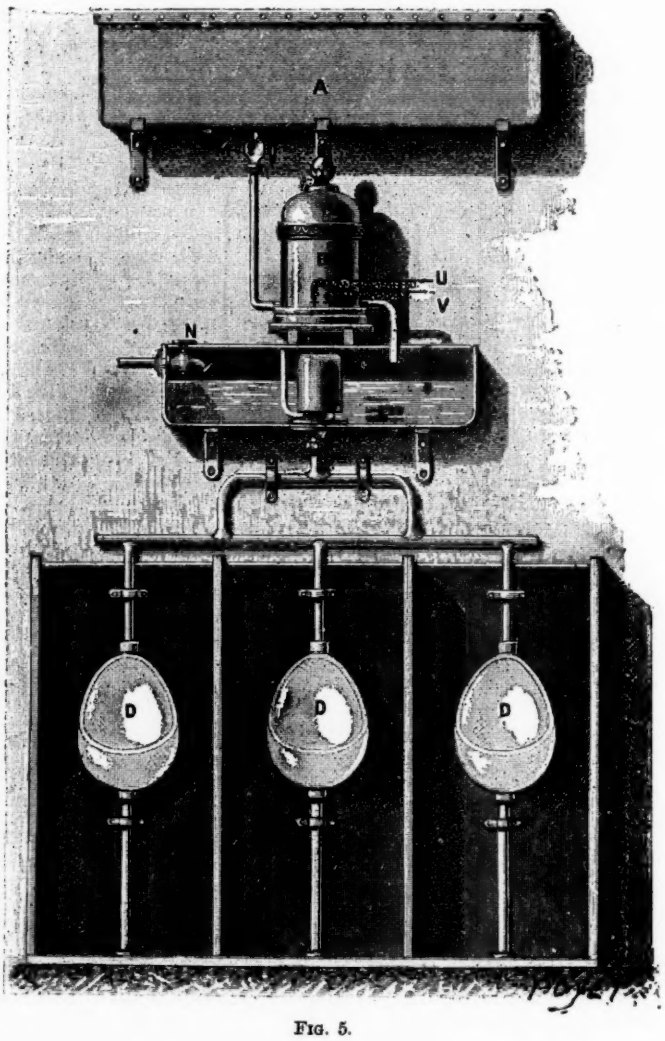


Fig. 5.

To this has to be added the trifling cost of the salts necessary when sea water is not available.

It is manifest, therefore, that in a private house where only a few gallons per day would be required, the cost need not be considered; and that in a hospital or public building where large quantities of disinfectants are employed at a merely nominal cost, a disinfectant solution can be obtained as required which is more efficient than any other disinfectant, and free from any of their drawbacks.

On board a steamer fitted with the electric light, and with a salt-water supply always at hand, an unlimited supply of disinfectant can be produced at practically no cost. This is a matter of great importance for ships trading in the tropics.

THE PACIFIC CABLE.

The temporary postponement of the Intercolonial Conference in consequence of the Australian delegates being flood-bound in British Columbia, gave the correspondent of the *Cape Times* at Ottawa an opportunity of taking an advance observation of the chief specific object of the conference, the discussion of which was to be held with closed doors. Our contemporary, in its August 1st issue, states that it has since been apprised by electric message of the result arrived at and of the special interest of the South African colonies in that result. Some weeks, however, must elapse, says our contemporary, before we can receive any full or satisfying statement of the proceedings at Ottawa; and meanwhile the following summary of the cable question may be deemed of interest even to those who are disposed to reject as visionary the project of a South African connection with the Pacific cable. The British taxpayer has a personal interest in the subsidising—the guarantee suggested being £145,000 a year—of the proposed extension from Australia to Canada. For thus the nervous system of the empire would be reinforced, commerce and amity promoted, and an important defensive agency provided for time of war, affording means of issuing distinct warnings and orders, and of ascertaining at what point protection of the merchant fleet is most urgently needed. With regard to South Africa, on the other hand, it may be objected that a cable service is already supplied on either side of the continent, and that the route of commerce is therefore sufficiently guarded. Upon this point we shall have more to say when our delegates come home. For the present it will suffice to discuss the question in its general bearing.

Washington Irving said that John Bull sat like a bottle-bellied old spider with his webs all round him covering the world, ready to pounce on anybody unfortunate enough to be caught in them. The Pacific cable will be a new thread in the cobweb, for there is as yet no cable across the Pacific Ocean. Were the British Empire and the United States in reality so near a union of hearts as Sir George Grey and others fondly believe, some of the ground might be cut from under the feet of those who propose this cable—for the Americans badly want a cable of their own, *via* San Francisco; and from recent newspaper articles it is pretty evident that if the Pacific cable is not

pushed through the Americans will be quick to seize their chance. In fact they are grumbling already that their Government has allowed the Pacific cable to go so near to practicability before bestirring themselves, since the cable, first in the field, will obviously stand a good chance of being the only one for a long time to come. But neither the American scheme *via* San Francisco and Honolulu, nor the French scheme *via* New Caledonia, however much we may wish to promote international amity, is likely to commend itself to the majority of those anxious to conserve the British Empire alike through peace and war. There is such a thing as being over-reached by diplomacy. When the Behring Sea fisheries were a subject of dispute, the British Columbians loudly complained that the American diplomatists were too ready to use sharp practice against John Bull, that Mr. Blaine, for instance, having leased the Alaskan sealing rights to an American company, managed to give that company one or two seasons of absolutely unopposed sealing, whilst the British colonists were driven away by their own war vessels. Other instances in which John Bull has been over-reached by his competitors readily suggest themselves. To give the most recent instances of the danger of dallying, there is the action of Hawaii—and we may take it that Hawaii, in this case, had American inspiration—in regard to the acquisition of Neckar Island. This little island in the Pacific has been taken notice of in British schemes for the Pacific cable, as being an island very valuable as a resting place for the cable (one technical question in regard to the cable being the feasibility of laying such great lengths as are necessary). Neckar Island, moreover, was "unoccupied" by any Power, and the idea was, of course, that, with a view to a cable route entirely under British control, this island would be taken possession of by one of Her Majesty's warships. But either no orders were given, or Her Majesty's warship took matters too easily, with the result that the Hawaiians one day sent out a fast ship to Neckar Island, stuck up her flag there, and claimed the island as their own—of course, with the sole object of making the British cable promoters pay stiffly for it if they want it, or, on the other hand, of hindering the construction of the British cable, and thus furthering American interests. Should the British authorities decide that the Pacific cable will be of use, this question of Neckar Island may be one cause of trouble, delay and expense, and the alleged dilatoriness of the Admiralty with regard to soundings in the Pacific will be another. After the Colonial Conference of 1887, when the colonies collectively urged the Government to have a nautical survey made to ascertain the practicability of the cable scheme, the Admiralty undertook to make a hydrographic survey on the route from New Zealand to Vancover. But the surveying ship *Egeria* went out with such instructions that many years would elapse before the work was completed. The Canadians and Australians, who were deeply concerned and very much in earnest, strongly urged that the work should be accelerated, and their request was supported by the Governor-General of Canada. They were willing to share the cost, if that were the obstacle. Their chagrin may be imagined when they learnt three or four months ago that instead of accelerating the survey the Admiralty had stopped it altogether, the *Egeria* having been withdrawn three and a half years ago.

The value of the cable to Great Britain is not at first sight so obvious as is its value to Canada and Australia, which communities foresee attractive possibilities of trading together, and would obtain the substantial boon of a cable rate of 2s. 9d. a word as between the American Continent and Australia, with a rate of 3s. 3d. a word between Australia and England. But it is only necessary to have a breakage such as occurred a year or two ago to the Eastern Extension Company's cable, when Australia was in telegraphic isolation from the rest of the world so long as the breach was unmended, for commercial men in England to understand the value of an alternative route even in the piping times of peace. In war time that value is indefinitely increased. How great was the value of the cable from Madeira when Sir Donald Currie's ship flew from Cape Town with the news of the Isandhlwana disaster. How great would be the value of a cable from India in case of another mutiny, or of a message from Australia in the conceivable eventuality of a foreign occupation. One thing of vast direct and indirect importance in the event of war would be the safety of that immense yet almost helpless merchant fleet which carries British commerce to the furthest corners of the earth. If the Suez Canal were closed, as it easily might be, the broad Atlantic and the broader Pacific, the Cape of Good Hope route, the Cape Horn route, and that Canadian route, which is the real "north-west passage that so many old-time navigators tried to find by water instead of land, these routes would be our resources, and perhaps of greater importance to parts of the Empire at a distance from England than to England itself. The ability of the British Navy to protect seagoing commerce, and thus prevent panic and loss, depends on the arrangement of details beforehand. As Captain Cragie pointed out in his "Naval Prize Essay" in 1892, exact alternative routes have to be agreed upon beforehand—say, in the case of the Atlantic, route A, 50 miles westward of St. Helena, route B, 100 miles westward of St. Helena, and so on. All shipowners and masters would be made acquainted with these routes. When war broke out, one of these routes would be selected, and all commerce would have to go by that route if the protection of the navy were desired, for Her Majesty's iron police would patrol that beat only. Ships here and ships there would have to be told of the routes, which would be telegraphed out confidentially from the Admiralty. When necessary the route might be changed in the same way—route A to route C and so on. Thus the navy could do its police work, and commerce might laugh at Alabamas. Such a scheme is easily comprehended. So, too, is its dependence on the existence of a safe cable. There are now five possible means of telegraphing from London to the East and Australasia, but it is argued that as none is entirely under British control, none is safe. One wire goes by way of Gibraltar, Malta, and the Red Sea; a second through France, Italy, Greece, and the Red Sea; a third through Germany, Austria, Turkey, Russia, and Persia; a fourth through Russia to the Pacific Coast, thence by China and India; a fifth up and down round South Africa. If South Africa had a direct cable to Australia this last would be good, but there is a million sterling in the way. The proposed cable across the Pacific would go just the contrary way to all these in girding the globe. We have 10 cables across the Atlantic, an all-British telegraph across Canada (worked by the Canadian Pacific Railway Company), and from Vancouver the new cable would carry on the route to Australia, where it would be in touch with the existing lines to Asia, and so round to Africa and Europe again. There is a choice of routes across the Pacific, notwithstanding Hawaii and her Neckar enterprise. We may go from Vancouver, the Pacific port of British Columbia to Fanning Island, Fiji, Norfolk Island, New Zealand, and New South Wales. Or to Neckar Island, Fiji, North Island, &c. Or to Neckar Island, Onatoa (Gilbert Group), Fiji, New Zealand. Or to Neckar, Apamana (Gilbert Group), San Christoral (Solomon Group), Queensland, and New Zealand. The length is from 6,244 nautical miles (Vancouver-Apamana-Queensland) to 8,264 (Vancouver-Onatoa-Queensland). Avoiding Neckar, the Fanning route is 7,145 miles. Last year over 1,300,000 words were cabled between Europe and Australia. The advocates of the new cable estimate that it would cost for interest on capital, renewal fund and interest, £144,350 per annum, and that if worked by the governments jointly at a cheap rate (2s. 6d. Canada-Australia) it would pay its way in four years.

THE UNITED STATES NEW TARIFF ACT.

Comparison of the Tariff and Administrative Acts of 1890 and the Bill, H. R. 4,864, as it passed the Senate July 2nd, 1894 (Calendar Day, July 3rd), with Rates of said Bill as it passed the House, and of the Mills Bill of 1888.—Washington, Government Printing Office, 1894.

This bulky volume prepared under the direction of the Committee of Finance, containing the provisions of the New Tariff Act of the United States, with a comparison of the late existing duties, for the new duties became law on August 27th, 1894.

For some 30 years the United States have been pouring into this country enormous amounts of corn, cotton, and other food stuffs and raw materials, and have, by laying the heaviest of duties upon imports, thought that they were thereby compelling England, which is not a gold producing country, to pay for the same in gold. Why they should have striven so hard to cripple their best customer does not appear, for it is certain that we have done a good deal to keep the Western farmer going, to find business for the railroads and employ American labour. And what has been the effect on America? Farm mortgages held—in London! Railway bonds—ditto!! Shipping under England's flag!!! And we have the gold still. True, we have not escaped scathless. We should have been better off if Americans had been wiser, but we have suffered less than they. The New Tariff Bill is the first indication in a practical form of an awakening to the follies of all tariffs that America has exhibited, and though duties are still exceedingly heavy, they have in many cases been very considerably reduced in appearance.

The new list is, like all such documents, confusing and contradictory. Copper wire has no place in it except as it is included under paragraph 177, but it is satisfactory, no doubt, to someone to find "Fenugreek" sced properly provided for in the free list. So, too, cotton rope is deserving only of the inclusive paragraph 264, which provides 35 per cent. of duty, whereas, in another article America has gone one better than the old English table of duties for Divi-divi is free, this being the article referred to by Bright in one of his speeches as being at one end of a long list with corn at the other. Bright was allowing the protectionist's claim, viz., that they were willing to abolish duties, and declared that they only differed from the League in the manner of procedure. We, said the Free Trader, commence to free corn; they start upon Divi-divi. Now, it seems to us very much as though the Americans had started on this same Divi-divi; and seeing how little effect duties have had in improving the condition of the people, we wonder why they could not have gone the whole hog and wiped out the whole silly list, as we did ourselves half a century since, without any resultant harm and with great benefit.

There appears to be an impression, however, that even the reductions made will put it in the power of Americans to do business with us and other nations to a greater extent, and we have, therefore, prepared some extracts from the above published report which we are warned by good authority may be incorrect, there being no really absolute copy of the tariff yet to hand in England.

The extracts we have made have more especially a bearing on the electrical trades. The figures before each paragraph are the clause numbers of the new list. To each we append the old law clause number where one is applicable. It must be noted that when an article is composed of two materials which bear, when separate, different imposts, then the duty is charged upon that constituent which forms the major part of the value. Thus in incandescent lamps — these are not specially scheduled — the duty on the whole would be levied upon the basis of either the platinum rate or the glass rate, whichever was the more valuable, or upon the carbon, we presume, if this formed the chief constituent. The glass comes under the residual charge for "all other manufactures of glass not specially provided for in the Act." Clause 102. The duty is 35 per cent. *ad valorem*. The platinum comes under the similar residual clause for metals (No. 177), and also carries 35 per cent., so that there is no question as to the relative value of the two constituents. Possibly if anyone showed that the

carbon filament was the most costly there might arise a nice little question under Clause 181, which is the only one that appears to bear on certain filaments, unless Clause 313 were applicable. We have endeavoured to pick out the clauses which seem more especially to bear on the electrical trades, but do not in all cases print the full clause, and have omitted the words *ad valorem* in every case after per cent., and also the repetition of the words pound or cent., and others were these are superfluous. Where per cent. is given *ad valorem* is understood, and, doubtless, have made many omissions. The new clause is printed first, the old law with its clause number follows.

47. Zinc, oxide of, and white paint or pigment containing zinc, dry or ground in oil, 1 cent per lb.

60. OLD LAW.—Zinc, oxide of, and white paint containing zinc, but not lead, dry, 1¼ cents; ground in oil, 1¾ cents.

52. White lead, white paint, and pigment containing lead, dry or in pulp, or ground or mixed with oil, 1½ cents per lb.

67. OLD LAW.—3 cents.

54. Potash.—Bichromate and chromate 25 per cent.

69. OLD LAW.—3 cents per lb.

57. Prussiate of potash, red or yellow, 25 per cent.

OLD LAW.—Red, 10 cents; yellow, 5 cents per lb.

60. Products or preparations known as alkalies, alkaloids, distilled oils, essential oils, expressed oils, rendered oils, and all combinations of the foregoing, and all chemical compounds and salts, not specially provided for in this Act, 25 per cent.

76. OLD LAW.—Same.

65. Caustic soda, ½ cent per lb.

81. OLD LAW.—1 cent.

67. Soda crystals, ½ cent per lb.; soda ash, ¼ cent.

83. OLD LAW.—¼ cent per lb.

76. Brick and Tile.—Not glazed, enamelled, or decorated in any manner, 25 per cent.; glazed, enamelled, ornamented, or decorated, 30 per cent.

OLD LAW.—See paragraph 94.

77. Magnesic fire-brick, $1 per ton.

93. OLD LAW.—Fire-brick, not glazed, enamelled, ornamented, or decorated in any manner, $1 25 cents per ton; glazed, enamelled, ornamented or decorated, 45 per cent.

78. Tiles, plain and encaustic, not glazed, ornamented, painted, enamelled, vitrified, or decorated, and encaustic 25 per cent., ornamented, glazed, painted, enamelled, vitrified, or decorated, 40 per cent.

94. OLD LAW.—Tiles and brick, other than fire-brick, not glazed, &c., 25 per cent.; ornamented, &c., and all encaustic, 45 per cent.

79. Cement, Lime and Plaster.—Roman, Portland, and other hydraulic cement, in barrels, sacks, or other packages, 8 cents per 100 lbs., including weight of barrel or package; in bulk, 7 cents per 100 lbs.; other cement, 10 per cent.

95. OLD LAW.—Roman, Portland, and other hydraulic cement, in barrels, sacks, or other packages, 8 cents per 100 lbs., including weight of barrel, or package; in bulk, 7 cents per 100 lbs.; other cement, 20 per cent.

80. Lime, 5 cents per 100 lbs., including weight of barrel or package.

96. OLD LAW.—6 cents per 100 lbs.

81. Plaster of Paris, or gypsum, ground, $1 per ton; calcined, $1 and 25 cents.

97. OLD LAW.—Plaster of Paris or gypsum, ground, $1 per ton; calcined, $1 and 75 cents.

83. Earthenware and China.—Common yellow and brown earthenware, plain or embossed, common stoneware, and crucibles, not decorated in any manner, 20 per cent.

99. OLD LAW.—25 per cent.

88. Glass and Glassware.—Green and coloured, moulded or pressed, and flint and lime glass bottles holding more than 1 pint, and demijohns and carboys, covered or uncovered, filled or unfilled, contents dutiable or free, and other moulded or pressed green and coloured and flint or lime bottle glassware, not specially provided for in this Act, ¾ cent per lb., and vials holding not more than 1 quart and not less than ¼ of a pint, 1½ cents per lb.; if holding less than ¼ of a pint, 40 cents per gross; all other plain green and coloured, moulded or pressed, and flint and lime and glassware, 40 per cent.

103. OLD LAW.—Green, and coloured, moulded or pressed, and flint, and lime glass bottles, holding more than 1 pint, and demijohns, and carboys (covered or uncovered), and other moulded or pressed green and coloured and flint or lime bottle glassware, not specially provided for in this Act, 1 cent per lb. Green, and coloured, and moulded or pressed, and flint, and lime glass bottles, and vials holding not more than 1 pint and not less than ¼ of a pint, 1½ cents per lb; if holding less than ¼ of a pint, 50 cents per gross.

102. All stained or painted glass windows, &c., and all manufactures of glass, or of which glass is the component of chief value, not specially provided for in this Act, 35 per cent.

122. OLD LAW.—45 per cent.

107. Grindstones, finished or unfinished, 10 per cent.

129. OLD LAW.—$1¾ per ton.

108. Slates, &c., and all other manufactures of slate, not specially provided for in this Act, 25 per cent.

130. OLD LAW.—30 per cent.

113. Beams, girders, joists, angles, channels, car-truck channels, T. T. columns and posts or parts or sections of columns and posts, deck and bulb beams, and building forms, together with all other structural shapes of iron or steel, whether plain or punched, or fitted for use, $\frac{6}{10}$ cent per lb.

137. OLD LAW.—$\frac{9}{10}$ cent per lb.

115. Forgings of iron or steel, or forged iron or steel combined, of whatever shape, or in whatever stage of manufacture, not specially provided for in this Act, 1½ cents per lb.: Provided, that no forgings of iron or steel, or forgings of iron and steel combined, by whatever process made, shall pay a less rate of duty than 35 per cent.

139. OLD LAW.—$2\frac{3}{10}$ cents per lb.: Provided, that no forging shall pay less than 45 per cent.

117. Railway bars, of iron or steel, and railway bars in part of steel, T rails, and punched iron or steel flat rails, $\frac{7}{20}$ cent per lb.

141. OLD LAW.—$\frac{6}{10}$ cent.

122.—Steamer, crank, and other shafts; shafting; wrist or crank pins; connecting rods and piston rods: pressed, sheared, or stamped shapes; alloys used as substitutes for steel in the manufacture of tools; all descriptions and shapes of dry sand, loam, or iron-moulded steel castings; sheets and plates not specially provided for in this Act; and steel in all forms and shapes not specially provided for in this Act; all of the above valued at 1 cent per lb. or less, $\frac{3}{10}$ cent per lb.; valued above 1 cent and not above $1\frac{4}{10}$ cents per lb., $\frac{4}{10}$ cent per lb.; valued above $1\frac{4}{10}$ cents and not above $1\frac{6}{10}$ cents per lb., $\frac{6}{10}$ cent per lb.; valued above $1\frac{6}{10}$ cents and not above $2\frac{2}{10}$ cents per lb., $\frac{7}{10}$ cent per lb.; valued above $2\frac{2}{10}$ cents and not above 3 cents per lb., $\frac{8}{10}$ cent per lb.; valued above 3 cents per lb. and not above 4 cents per lb, $1\frac{2}{10}$ cents per lb.; valued above 4 cents and not above 7 cents per lb., $1\frac{8}{10}$ cents per lb.; valued above 7 cents and not above 10 cents per lb., $1\frac{9}{10}$ cents per lb.; valued above 10 cents and not above 13 cents per lb, $2\frac{4}{10}$ cents per lb.; valued above 13 cents and not above 16 cents per lb., $2\frac{5}{10}$ cents per lb.; valued above 16 cents per lb. $4\frac{7}{10}$ cents per lb.

146. OLD LAW.—All of the above valued at 1 cent. per lb. or less, $\frac{4}{10}$ cent per lb.; valued above 1 cent and not above $1\frac{4}{10}$ cents per lb., $\frac{5}{10}$ cent per lb.; valued above $1\frac{4}{10}$ cents and not above $1\frac{6}{10}$ cents per lb., $\frac{6}{10}$ cent per lb.; valued above $1\frac{6}{10}$ cents and not above $2\frac{2}{10}$ cents per lb., $\frac{9}{10}$ cent per lb.; valued above $2\frac{2}{10}$ cents and not above 3 cents per lb., $1\frac{2}{10}$ cents per lb.; valued above 3 cents and not above 4 cents per lb., $1\frac{6}{10}$ cents per lb.; valued above 4 cents and not above 7 cents per lb., 2 cents per lb.; valued above 7 cents and not above 10 cents per lb., $2\frac{8}{10}$ cents per lb.; valued above 10 cents and not above 13 cents per lb., $3\frac{1}{2}$ cents per lb.; valued above 13 cents and not above 16 cents per lb., $4\frac{2}{10}$ cents per lb.; valued above 16 cents per lb., 7 cents per lb.

124. Round iron or steel wire, all sizes not smaller than 13 wire gauge, 1½ cents per lb.; smaller than 13 gauge and not smaller than 16 gauge, 1½ cents. Smaller than 16 gauge 2 cents; all other iron or steel wire and wire or strip steel, commonly known as crinoline wire, corset wire, drill rods, needle wire, piano wire, clock and watch wires, and all steel wires, polished or unpolished, in coils or straightened, and cut to lengths, drawn cold through dies, and hat wire, flat steel wire, or sheet steel in strips, uncovered or covered with cotton, silk or other material or metal, and all the foregoing manufactures of iron or steel, of whatever shape or form, valued above 4 cents per lb., shall pay a duty of 40 per cent.: provided, that articles manufactured from iron or steel wire shall pay the maximum rate of duty which would be imposed upon any wire used in the manufacture of such articles, and in addition thereto 1 cent per lb.

148. OLD LAW.—Wire of iron or steel, not smaller than No. 10 wire gauge, 1¼ cents per lb.; smaller than No. 10, and not smaller than No. 16 gauge, 1¾ cents; smaller than No. 16 and not smaller than No. 26, 2¼ cents; smaller than No. 26 gauge, 3 cents: provided, that iron or steel wire covered with cotton, silk, or other material, and wires or strip steel, commonly known as crinoline wire, corset wire, and hat wire, shall pay a duty of 5 cents per lb.; and, further, that flat steel wire, or sheet steel in strips, whether drawn through dies or rolls, untempered or tempered, of whatsoever width, $\frac{25}{1000}$ of an inch thick or thinner (ready for use or otherwise), shall pay a duty of 50 per cent.: and, further, that no article made from iron or steel wire, or of which iron or steel wire is a component part of chief value, shall pay a less rate of duty than the iron or steel wire from which it is made either wholly or in part: and provided, further, that iron or steel wire cloths, and iron or steel wire nettings made in meshes of any form, shall pay a duty equal in amount to that imposed on iron or steel wire used in the manufacture of iron or steel wire cloth, or iron or steel wire nettings, and 2 cents per lb. in addition thereto.

There shall be paid on iron or steel wire coated with zinc or tin, or any other metal (except fence wire and iron or steel, flat, with longitudinal ribs, for the manufacture of fencing), ½ cent per lb. in addition to the rate imposed on the wire of which it is made; on iron wire rope and wire strand, 1 cent per lb. in addition to the rate imposed on the wire of which it is made; on steel wire rope and wire strand, 2 cents per lb. in addition to the rate imposed on the wire of which they or either of them are made: provided, further, that all iron or steel wire valued at more than 4 cents per lb. shall pay a duty of not less than 45 per cent. *ad valorem*, except that card wire for the manufacture of card clothing shall pay a duty of 35 per cent.

125. General Provisions.—No allowance or reduction of duties for partial loss or damage in consequence of rust or discolouration shall be made upon any description of iron or steel, or upon any article wholly or partly manufactured of iron or steel.

149. OLD LAW.—Same.

126. Anchors, or parts thereof, of iron or steel, mill irons and mill cranks of wrought-iron, and wrought-iron for ships, and forgings of iron or steel, or of combined iron and steel, for vessels, steam engines and locomotives, or parts thereof, $1\frac{2}{10}$ cents per lb.

153. OLD LAW.—$1\frac{2}{10}$ cents.

127. Axles, or parts thereof, axle bars, axle blanks, or forgings for axles of iron or steel, without reference to the stage or state of manufacture, 1½ cents per lb.: provided, that when iron or steel axles are imported fitted in wheels, or parts of wheels, of iron or steel, they shall be dutiable at the same rate as the wheels in which they are fitted.

154. OLD LAW.—2 cents.

128. Anvils of iron or steel, or of iron and steel combined, by whatever process made, or in whatever stage of manufacture, 1¾ cents per lb.

155. OLD LAW.—2½ cents.

129. Blacksmiths' hammers and sledges, track tools, wedges and crowbars, whether of iron or steel, 1½ cents per lb.

156. OLD LAW.—2½ cents.

130. Boiler or other tubes, pipes, flues, or stays of wrought iron or steel, 25 per cent.

157. OLD LAW.—2½ cents per lb.

131. Bolts with or without threads or nuts, or blank, 1½ cents per lb.

158. OLD LAW.—2½ cents.

133. Cast-iron pipe, all descriptions $\frac{6}{10}$ cent per lb.

160. OLD LAW.—$\frac{9}{10}$ cent per lb.

135. Malleable iron castings, $\frac{9}{10}$ cent per lb.

162. OLD LAW.—1½ cents.

137. Chains of iron or steel, all kinds, 30 per cent.

152. Railway fishplates or splice bars of iron or steel, 25 per cent.

181. OLD LAW.—1 cent per lb.

153. Iron or steel rivets, 25 per cent.

182. OLD LAW.—2½ cents per lb.

156. Wheels for railway purposes, or parts thereof, of iron or steel, and steel-tired wheels for railway purposes, wholly or partly finished, iron or steel locomotive, car, or other railway tires or parts thereof, wholly or part manufactured, and ingots, cogged ingots, blooms, or blanks for the same, without regard to the degree of manufacture, 1¼ cents per pound: Provided, that when wheels or parts thereof, of iron or steel, are imported with iron or steel axles fitted in them, the wheels and axles together shall be dutiable at the same rate as is provided for wheels when imported separately.

185. OLD LAW.—1¾ cents per lb. with same proviso.

157. Aluminium, in crude form, alloys of any kind in which aluminium is the component material of chief value, 10 cents per lb.

186. OLD LAW.—15 cents per lb.

161. Copper.—Copper in rolled plates, called braziers' copper, sheets, rods, pipes, and copper bottoms, also sheathing or yellow metal of which copper is the component material of chief value, and not composed wholly or in part of iron ungalvanised, 20 per cent.

195. OLD LAW.—35 per cent.

167¾. Mica, 20 per cent.

202. OLD LAW.—35 per cent.

175. Zinc in sheets not polished or further advanced than rolled, 1¼ cent per lb.

213. OLD LAW.—2½ cents.

174. Zinc or Spelter.—Zinc in blocks or pigs, 1 cent per lb.

212. OLD LAW.—1¾ per cent.

177. Manufactured articles or wares, not specially provided for in this Act, composed wholly or in part of any metal, and whether partly or wholly manufactured, 35 per cent.

215. OLD LAW.—45 per cent.

264. All manufactures of cotton, including cotton duck and cotton damask, in the piece or otherwise, not specially provided for in this Act, and including cloth having India-rubber as a component material, 35 per cent.

355. OLD LAW.—Cotton damask, in the piece or otherwise, and all manufactures of cotton not specially provided for in this Act, 40 per cent.

Clause 264 will include cotton driving ropes.

268. Cables, cordage, and twine (except binding twine), composed in whole or in part of New Zealand hemp, istle or Tampico fibre, manilla, sisal grass, or sunn, 10 per cent.

362. OLD LAW.—Cables, cordage, and twine (except binding twine), composed in whole or in part of istle or Tampico fibre, manilla, sisal grass, or sunn, 1½ cents: all binding twine manufactured in whole or in part from istle or Tampico fibre, manilla, sisal grass, or sunn, $\frac{7}{10}$ cent; cables and cordage made of hemp, 2½ cents per lb.; tarred cables and cordage, 3 cents.

277. All manufactures of flax, hemp, jute or other vegetable fibre (except cotton) or of which these substances, or either of them, is the component material of chief value, not specially provided for in this Act, 35 per cent.

OLD LAW.—All manufactures of flax or hemp, or of which these substances, or either of them, is the component material of chief value, not specially provided for in this Act, 50 per cent.

All manufactures of jute, or other vegetable fibre, except flax, hemp, or cotton, or of which jute, or other vegetable fibre (except flax, hemp, or cotton), is the component material of chief value, not specially provided for in this Act, valued at 5 cents per lb. or less, 2 cents per lb.; valued above 5 cents per lb., 40 per cent.

313. Manufactures of paper, or of which paper is the component material of chief value not specially provided for in this Act, 20 per cent.

OLD LAW.—25 per cent.

340. Bend or belting leather, and leather not specially provided for in this Act, 10 per cent.

455. OLD LAW.—Same.

352. Manufactures of bone, chip, horn, India-rubber, palm leaf, whalebone, or of which these substances, or either of them, is the component material of chief value, not specially provided for in this Act, 25 per cent.

OLD LAW.—30 per cent.

353. Manufactures of leather, fur, gutta-percha, vulcanised India-rubber (known as hard rubber), human hair, paper maché, plaster of Paris, indurated fibre wares, and other manufactures composed of wood or pulp, or of which these substances, or either of them, is the component material of chief value, all of the above not specially provided for in this Act, 30 per cent.

461. OLD LAW.—35 per cent.

This finishes the list of dutiable articles, and then follows the free list, containing, amongst others the following articles:—

Clause 363. Acids used for medicinal, chemical, or manufacturing purposes, not especially provided for in this Act. This clause includes sulphuric acid, as to which, however, there is a retaliatory proviso in Clause 643. That upon sulphuric acid imported from any country, whether independent or a dependency, which imposes a duty upon sulphuric acid exported from the United States, there shall be levied, and collected, the rate of duty existing prior to the passage of this Act; but under the old law this acid seems to have been free, so that, like many measures of retaliation, this does not seem to fit, and after this bit of spite we are treated, in Clause 393, to free Balm of Gilead; tempered again in Clause 405 by blue vitriol, or sulphate of copper.

12. OLD LAW.—2 cents per lb.

455. Copperas, or sulphate of iron.

23. OLD LAW.—$\frac{3}{10}$ cent per lb.

468. Divi-divi, our old historic friend.

585. Philosophical and scientific apparatus, utensils, instruments and preparations, including bottles and boxes containing the same; statuary casts of marble, bronze, alabaster, or plaster of Paris; paintings, drawings and etchings, specially imported in good faith for the use of any society or institution incorporated or established for religious, philosophical, educational, scientific, or literary purposes, or for encouragement of the fine arts, and not intended for sale.

This clause reminds us of the 24 solid lead statues of the late Lord Brougham, not omitting the characteristic nasal organ, which stood in a row on the quay at Baltimore pending the decision as to whether they were pig lead or works of art. Art carried the day and Brougham entered free, but the climate proved hot enough to melt him down almost in sight of the Custom House.

589. Platina, in ingots, bars, sheets, and wire.

590. Platinum, unmanufactured, and vases, retorts, and other apparatus, vessels, and parts thereof composed of platinum, adapted for chemical uses.

687. Works of art, drawings, engravings, photographic pictures, and philosophical and scientific apparatus brought by professional artists, lecturers, or scientists arriving from abroad for use by them temporarily for exhibition and in illustration, promotion, and encouragement of art, science, or industry in the United States, and not for sale, and photographic pictures, imported for exhibition by any association established in good faith and duly authorised under the laws of the United States, or of any State, expressly and solely for the promotion and encouragement of science, art, or industry, and not intended for sale, shall be admitted free of duty, under such regulations as the secretary of the Treasury shall prescribe; but bonds shall be given for the payment to the United States of such duties as may be imposed by law upon any and all such articles as shall not be exported within 6 months after such importation: Provided, that the secretary of the Treasury may, in his discretion, extend such period for a further term of 6 months in cases where applications therefor shall be made.

758. OLD LAW.—No change, except that "paintings and statuary" were included after "photographic pictures."

Here follow various covering sections to catch the fish that might otherwise slip by the net, thus:—

Section 3 provides that there shall be paid on the importation of all raw or unmanufactured articles, not enumerated or provided for in this Act, a duty of 10 per cent.; and on all articles manufactured, in whole or in part, not provided for in this Act, a duty of 20 per cent.

Section 4, that every imported article, not enumerated in this Act, similar in material, quality, texture, or use, to any article enumerated as chargeable shall pay the rate levied on the enumerated article it most resembles in any of the particulars before mentioned; and if any non-enumerated article equally resembles two or more enumerated articles on which different rates of duty are chargeable, there shall be levied on such non-enumerated article the same rate of duty as is chargeable on the article which it resembles paying the highest rate of duty; and on articles not enumerated, manufactured of two or more materials, the duty shall be assessed at the highest rate at which the same would be chargeable if composed wholly of the component material thereof of chief value; and the words "component material of chief value," wherever used in this Act, shall be held to mean that component material which shall exceed in value any other single component material of the article; and the value of each component material shall be determined by the ascertained value of such material in its condition as found in the article. If two or more rates of duty shall be applicable to any imported article it shall pay duty at the highest of such rates.

Section 5 provides for the proper marking of every article or package; honestly, legibly, and to indicate origin.

Section 6 deals with the non-simulating of any domestic trademark by an imported article.

Section 7 deals with rebates, &c., of material for shipbuilding, and there are other sections dealing with invoices, re-exportation, &c.

We do not rise from a perusal of this schedule with any heightened respect for American economic wisdom, and we have had the painful experience in New York of endeavouring to determine just what duties were really intended to be applied to certain articles. There may have been some sort of intentional originating point for various charges; but our research revealed something similar to the basis on which the railway porter must have worked when he tried to find a schedule rate for a tortoise. His decision was: "Cats is rabbits, and dogs is rabbits, but a tortoise is a insect."

So far as we can see steam engines will come under the clauses relating to iron or steel castings and forgings. Dynamos similarly, or perhaps all machinery will come simply under Clause 177, but we hesitate to place telephones or cables, being so complex in structure. It would appear, however, that the 35 per cent. rate applies to pretty well the bulk of manufactured articles which have any amount of structural form. Cables may come under Clause 177, or under Clause 352 or 353.

The duty of 35 per cent. is, however, so enormous that but little

can be expected from the change, and we do not anticipate any specially remarkable developments. Indeed it is evident that the protectionist party hold the situation, and that so far all the protests of the great agricultural interest go for nothing, the small reductions made being simply concessions of no real value to the public. There is no change at all commensurate with the outcry that has been made, and though, of course, a step in the direction of freer trade, it is so small a step that in its effects it will differ from the old régime about as much as any barrier of 35 feet differs from one of 45. They are both beyond reach.

WOODHOUSE & RAWSON UNITED, LIMITED.

Mr. F. L. Rawson's Statement.

(*Concluded from page* 241.)

With regard to the patents, he put in a letter to show that Mr. Edmunds valued the patents for the new directors, and further with regard to valuation of the patents he put in two extracts from the Electrical Review of July 29th, 1887. He stated that Woodhouse and Rawson United acted upon the regular plan of similar companies, namely, to write off all old patents, so that in 14 years all the patents standing in their balance-sheet would be only represented by the actual amount of the fees paid, no credit being taken for the cost of experiments or work done in connection with the new patents, notwithstanding that the lamp experiments were most costly, as they had to be carried out on a commercial scale. He gave examples of the value of patents of the description they held. With regard to some of the committee of consultation having tried to make out that he had endeavoured to overestimate the profits of the first year in order to get a larger commission for himself, he called attention to the fact that they might have taken in three or four items increased profit of some £5,000, which turned out afterwards to be profit available for that year. He also said that of the shares which formed part of the company's profits that year, although unsold at the date of the balance-sheet, were actually sold and paid for by the time that the balance-sheet was signed and his percentage agreed upon. Further, that he could have considerably increased the amount of his profit by taking advantage of what they were entitled to do in the articles of association, and not writing off to loss the amounts spent on special business which could only be remunerative in the future, the auditor having called special attention to this article, and having suggested that the company should take advantage of it. With regard to the insinuation that the Phœnix Trust took from Woodhouse & Rawson United three-fourths of the profits from the formation of the Phœnix and other limited companies, he showed that Woodhouse & Rawson United definitely decided in the middle of 1890 not to promote any companies, and refused to have anything to do with the formation of those Elmore companies, and it was only the fact of the Phœnix Trust Company promoting underwriting of capital that gave Woodhouse & Rawson any profits at all from those companies. Woodhouse & Rawson United got nearly half the profits with practically no risk. He next went into details of why he gave up half the founders' shares to Woodhouse & Rawson United as a present, and gave details as regards Mr. North's examination of the Kidsgrove property before the purchase was made. With regard to the suggestions that the directors had been unduly swayed by him, he gave seven important instances of the directors acting in opposition to his advice, the first being their objection to his interference with Mr. North in the industrial portion of the business after that gentleman's appointment as manager; Mr. Rawson gave his reason for his interference that he was suspicious of Mr. North, but stated that he could give no ground for his suspicions, although in his examination he gave the ground that made him suspicious at that date. The directors believing that Mr. Rawson was much overworked considered it best to leave matters in Mr. North's hands. Later it turned out that Mr. Rawson was right. They then against Mr. Rawson's strong objections appointed Mr. Stutchbury as the only manager, although Mr. Rawson stated that a first class man of considerable experience was required, and offered to pay half the salary of such a man out of his own pocket. Mr. Rawson took full responsibility for the arrangements made for Mr. Baker giving half his time to the Manchester works and half to Cadby Hall, and stated that it did not give Mr. Baker a fair chance of showing what he could do. With regard to the position of the subsidiary companies at the date of the purchase, he put in correspondence to show their success, and also put in various documents to the same effect. He further stated that the position of the companies was not kept hidden. He also referred to particulars from one of the financial papers and from the Electrical Review in between the date of the opening of the lists and the closing, giving particulars with regard to the position of the old companies. With regard to the particulars from the Electrical Review put in at different parts of his statement, he says that leading electrical papers, such as this, are absolutely above suspicion in descriptions of visits to works, and such matters can be relied upon. He then deals with the accounts and his advice with regard to the same, and calls attention to the difficulties of Woodhouse & Rawson, Limited, owing to the fact that by the contracts of sale, they not only had received no cash, but had to find cash themselves. With regard to himself personally, he directs attention to six instances where he had sacrificed himself in order to help companies with which he was connected, besides those already mentioned, and stated that the vote of £10,000 to him from Woodhouse & Rawson, Limited, was not for the formation of Woodhouse & Rawson United, but for the call that he had given up, worth £30,000, and for other various things he had done for that company. He then showed that his loan of £5,000 to the Phœnix Trust Company was never paid off, and that to help Woodhouse & Rawson United, he had taken securities at the date of the winding-up, and had actually never been repaid the amount of £929 16s. 10d. He did not know until the Official Receiver showed him the list of shareholders, that Baron Grant held a large share of capital in the National Financial Corporation. The company had never had any transactions with him; the whole of the transactions having been with the National Financial Corporation, and he had never made one penny out of any transactions with either Baron Grant or the National Financial. Not only had none of the directors ever sold any shares or debentures in Woodhouse & Rawson United, but the Rawson family had a very large holding, and never sold a share; he himself had steadily increased his holding in the company. He was very pleased to find that not one statement had been made as to any want of care being shown in his portion of the business. He showed by correspondence that Sir Albert Cappel had endeavoured to get Sir John Coode to change his mind about not going to allotment. He showed that Woodhouse & Rawson United articles of association were considerably amplified from those of Woodhouse & Rawson, Limited, so as to give the new company powers of doing financial business, and he quoted extracts from the shareholders' meeting, showing that the shareholders knew that the company were to do this business. He stated that for the purpose of finance, the term financial side of the business had been used as applicable to that portion of the business dealing with the patents. He showed that only one piece of business done by the company was strictly financial business, that Woodhouse & Rawson United would not themselves act as promoters, and that they never underwrote, never bought any shares in the market, or lent money, but were interested now and then in the promotion of companies, as is every electrical or engineering firm doing large business, for by the nature of their business they get their profits from the contract for the carrying out of the works with the new companies. He stated that the reason for their taking up this class of work was owing to his being largely consulted with reference to the formation of companies taking up patents and kindred matters, and then seeing what a great want there was for some company like themselves, who had the special necessary knowledge which would give their *cachet* to the patents that might be brought out. In stating what care was taken by the directors, he said that with regard to the shares and debentures, if he had to value them to-day by the light of knowledge of the previous date, he would value them again at the same price, with, possibly, the exception of the ordinary shares. He had no doubt that the securities would ultimately stand at the price they were then valued at. He deals with the report of the committee of consultation, and in the delay in its presentation having the effect of stopping the credit of the company, and causing it to wind up, stating it as his opinion that if the committee had assisted the company it would have been alive to-day. He gives twenty-two instances of the many statements in the report, which had, he stated, turned out to be incorrect—some of considerable importance—giving examples of other statements made against the directors that were unfounded, and showed that they had done the best they could in the interests of the shareholders, and carried on the business with care.

THE PATHOLOGY AND TREATMENT OF ELECTRIC ACCIDENTS.*

By W. S. HEDLEY, M.D. Edin.

If the living body become the path of an electrical current of dangerous magnitude, what are the nature and sequence of the lesions that ensue; and how may death occur? Not on account of its connection with lightning stroke, nor because of a ghastly interest it may derive from the process of "electrocution," but because of those accidents that occasionally occur in connection with electric light circuits it is that this question becomes chiefly interesting. It has an obvious practical bearing on the proper treatment to be pursued in attempting the resuscitation of persons injured by such accidents—if, indeed, it be permissible to speak of electrocution as an accident—and to hint at the possibility of reanimation. One of the most useful contributions to a knowledge of this subject is a communication made by M. D'Arsonval in 1887 to the Société de Biologie; and this has recently been followed up by interesting confirmatory evidence. It is considered that the alternating currents of commerce may cause death in either of two ways: (1) by actual lesion or destruction of tissue; and (2) by arrest of respiration, producing asphyxia. In the former class death is actual, and nothing can restore animation; in the latter (including electrocution) death may be, and at first often is, only apparent, recovery still being possible, and even probable, by a timely resort to artificial respiration. The following practical rule is therefore formulated: "Un foudroyé doit être traité comme un noyé." There is a limit, however, to this possibility of recovery. If the elevation of temperature produced by the passage of such currents exceed 45° death ensues, "as Claude Bernard has shown, by coagulation of the muscular fibres of the heart."† Should this point have been reached such cases pass into the first category of "mechanical destruction," and are not recoverable; but in accidents of the kind under consideration the contact is generally of short duration, and the

* *The Lancet.*

† According to Halliburton, *myosinogen* coagulates at 56°.

tetanic muscular contractions have not generally lasted long enough to induce the fatal elevation of temperature.*

It is thus considered that in cases of accidental contact with electric light wires the condition is generally one of suspended animation—of only apparent death—and that by the timely use of artificial respiration real and actual death can often be averted. In attempting the restoration of persons thus injured, those repeated rythmical tractions on the tongue known as the "Laborde" method for the treatment of asphyxia are advocated. It is the procedure which its originator, in his communication to the Academy of Medicine, called "the physiological treatment of death," and its technique is thus described: "With the thumb and index-finger, either bare or covered by a handkerchief, the tongue is seized by its anterior third, and powerful repeated rhythmical tractions and relaxations are carried out with a frequency of about 15 to 20 times a minute. In making these tractions it is important to feel that the dragging action affects the *root* of the tongue. If, in attempting to seize the tongue, it is found that the jaws are closed and the teeth clenched, open them by the finger, if possible, or use as a wedge a piece of wood or the handle of a pocket-knife, or anything of the kind that may be at hand."†

In illustration of the foregoing points an interesting case of recent occurrence is cited. Its details, as given by two electrical engineers who were eye-witnesses of the occurrence, and who assisted in the efforts at restoration, are as follows. It appears that with the voltmeter registering 4,500 volts and an ampèremeter marking 750 milliampères an alternating current was accidentally short-circuited through the body of a man. The point of entrance was the hand, and that of emergence the buttock. The duration of contact was "certainly many minutes." More than half an hour elapsed before artificial respiration was commenced, and during that time the man showed no sign of life. Arm movements were then carried out, without apparent effect; on practising the Laborde procedure, however, respiratory movements soon appeared, and in about two hours the man could speak. In the course of a few days he had quite recovered, excepting from the burns at the points of entry and exit. In such accidents the line of treatment to be pursued is sufficiently obvious. It is imperative that artificial respiration be promptly and patiently carried out. The pathology of the accident, however, seems by no means so simple. It is nearly a century and a half since Priestley, experimenting with Leyden jar discharges, showed that death might result from "electric shock" without structural lesion. Recent experiments, especially in electrocution, have abundantly demonstrated this. Such cases might perhaps come under D'Arsonval's second class, and it is allowable to speculate how far the result might have been averted by a timely resort to artificial respiration. How, then, in the absence of actual destruction of vital structures, may such accidents injure or kill? What part do the lungs, heart, and nervous system respectively play in the morbid process? How far is the process direct, or reflex, or inhibitory? Stimuli applied through the vagus or "almost any afferent nerve" will, by reflex effects through the bulb, influence respiration, and it may probably be accepted that, if the stimulation be very strong, respiratory action may be arrested in inspiratory tetanus. So far as the heart is concerned, the inhibitory action of the vagus will come into play. Ziemssen showed in his "classic" experiments that tetanising induction currents applied to the heart of the dog produced those irregular, arhythmic, fibrillar contractions spoken of as "delirium cordis," "caused by some change in the muscular fibres themselves." Is this change a coagulation by the heat resulting from the tetanic muscular contractions? The further experiments of Ziemssen with currents applied directly to the human heart with only pericardium intervening, as well as the experiments of Ludwig and Hoffa, of Biedermann, MacWilliam, Herbert, and Dixon Mann, are familiar through the text-books of physiology. Such experiments may possibly serve as a guide to ordinary therapeutic work, or as a starting-point in the controversy as to the risks of vagus stimulation in such conditions as chloroform narcosis or other intoxications; but they will not tell us how a modern industrial current may injure or kill. Further direct experimentation ought to be taken up from the point where the above-named investigators have left it. Cardiographic and respiratory tracings are wanted to show in sequence of time the nature and extent of the influence on circulation, respiration, and innervation of modern currents under various conditions of contact, strength, direction, and duration.

* M. D'Arsonval points out that the elevation of the central temperature produced by the passage of these strong currents is not due to the "resistance of the body to the passing current, in conformity with the laws of Joule, but to the violent contractions throughout the whole of the muscular system, and also to the condition of asphyxia, as Dr. Brown-Séquard has shown."

† "If the case be one of drowning, at the beginning of the proceeding, whilst holding the tongue with one hand, pass the index-finger of the other hand to the back of the fauces to induce vomiting, and clear the stomach as far as possible from water, food, &c."

CORRESPONDENCE.

The Alleged New Constituent of the Atmosphere.

The thanks of chemists are due to you for quoting the paper of one of England's greatest chemists, published more than a century ago; and as your readers will observe, in the year 1785, Cavendish published experiments on the atmosphere which demonstrated that it is devoid of any tangible quantity of anything which surpasses nitrogen in inertness.

The recent publication in the Chemical Section of the British Association of results in contradiction of Cavendish's work, appears to me to be founded upon failure to take into consideration the peculiarities of nitrous oxide. I have read the statement in the *Chemical News* on this subject, and in particular I note the passages relating to the new gas: "Its density is 18·9, if allowance is made for solubility in water, or 20·0 if no allowance is made."

Under the circumstances of the case this passage stamps the character of the work of the two modern investigators.

J. Alfred Wanklyn.

August 27th, 1894.

Portable Batteries.

I am much obliged to you for inserting my letter, and to Mr. FitzGerald for his reply. I am glad to see he has what appears to be a great improvement—great in its smallness—in weight. Of course the loss of time has to be considered, but, *prima facie*, I am almost inclined to think it would do at any rate for the purpose I had in view. I should, however, have said, as I wished to be understood, that the battery ought to stand the 12 watt periods besides the 2 watts for its lamp for the usual working shift.

A. W. Bennett.

August 27th, 1894.

Electrical Distribution by Alternating Currents.

My opinion of Mr. Lowrie's compound intraposed automatic system was based upon a description contained in the *Electrical Engineer* of the 27th ult. As Mr. Lowrie says that his switch works all right, I must conclude that the description was not a correct abstract from the specification. If so, I hope Mr. Lowrie will correct this abstract; the more so, because the point mentioned in my letter was not the only one which seemed to show a want of knowledge of the working of a transformer. I had good reason for believing that Mr. Lowrie's system was one of the numerous inventions which are patented before thorough experiments are made, as it has been pointed out on several occasions in this paper that the system had not yet been subjected to a practical test. I am glad to learn that I have been under a misapprehension in this respect. I am afraid I have been somewhat misled by the name of the system; as a rule, the value of a patent is inversely proportional to the square of the length of its name.

S. A. Faber.

Personal.

A circular letter, written by a gentleman with whom I was for some years connected, has been sent round which so evidently refers to myself that I feel bound to take notice of it, and should be glad if you will allow me to correct, through your columns, inferences made therein.

When I left that gentleman he was aware that I intended starting in business for myself, and also that I intended issuing a register of electrical plant for sale; these things were not done without his knowledge, and as by his statement he found it necessary to part with me, he did so quite knowing what I was about to do, and our parting was on the most friendly terms, and as he expressed a wish that we should have business transactions together, some apparatus which were his property were put in my register, that if he could not dispose of them I might be able to do so for him. As regards the mention of his name I did not consider that there could be the least objection to my stating that I had left that gentleman, and it was only in this way that the name was mentioned. As regards the alteration of address. When first I commenced, and before I had taken a City office, I had sent out notices from my address in the country, and the attention was called in my register to the change to the City address. As the letter was so evidently issued for the purpose of injuring me, I am bound, though with very much regret, to correct statements made with this palpable intention.

pro **Geo. Piggott & Co.**
G. E. Piggott

A Questionable Grievance.

Will you kindly inform us if a corporation, through their gas engineer, can legally compete with private firms for the installation of electric lighting in connection with the corporation electricity supply mains? We may state that the gas engineer gives no information respecting extension of mains, &c., but contents himself with issuing the accompanying "Rules," and canvassing most energetically, and in our opinion unfairly, using such arguments as that it is unsafe to deal with private firms, they being altogether unreliable, here to-day and gone to-morrow, &c., &c.

Of course, this is true in some instances, but surely not invariably.

Competition is so keen, that the corporations frequently offer to reduce their price below that of the private firms.

All this is, of course, most unfair, and has resulted in a desire on the part of honest and straightforward contractors to stop this injustice to a number of the ratepayers of this town.

We may further state that the gasfitters have been similarly treated for some few years.

Can we not remedy this state of affairs? The opinion asked for and that of your readers may assist us.

Ratepayer.

[It appears to us, from a glance at the accompanying "Rules," that as they are issued by the —— Corporation *Electricity Supply*, there is no reason why their engineer, even though he hails from the gas offices, should not try to do business in competition with private firms, so long as it is fairly conducted. There is no question but that the Corporation is legally entitled to compete, and to wire houses and supply current; indeed, for what other purpose has it instituted an electricity supply?—Eds. Elec. Rev.]

NOTES.

The Rumoured London-Berlin Telephone.—It appears that there is no foundation for the report of the impending establishment of direct submarine telephonic communication between London and Ostend, nor have any negotiations regarding such a project been commenced between the British and Belgian Governments.

The Unit Price at Dover.—It was stated the other day by an alderman at the Town Council's meeting, when a brief discussion arose as to the cost of the electric light, that the price they are to pay for electric current will be equivalent to 6s. 8d. per 1,000 feet of gas, instead of 2s. 6d., as formerly. The price to be charged is 8d. per B.T. unit. What does Mr. W. H. Preece say to this? How does it tally with his calculations? He has recommended Yarmouth Council to charge 6d. per unit, which, according to his statement, is equal to gas at 3s. per thousand.

Platinum Resistance Thermometers.—Prof. G. Carey Foster has addressed the following letter to *Nature*:—"At the meeting of the British Association it was pointed out to the Committee of Section A, by Mr. E. H. Griffiths, that the general adoption of the method of thermometry, founded on the variation of the electric resistance of platinum with temperature, that has been worked out by Prof. Callendar and himself, is seriously hindered by the existence of a report presented to the Belfast meeting of the Association in 1874 (British Association Report, 1874, pp. 242—249), by a Committee 'appointed for the purpose of testing the new pyrometer of Mr. Siemens.' As I was secretary of this committee, and drafted the report, and as all the experiments were made either by myself or under my direction, I was desired by the Committee of Section A to ask you to allow me to state in the columns of *Nature* (what is indeed obvious to anyone who refers to the 1874 report) that the tests carried out by the Committee of 1874, and the conclusions arrived at by them, had reference solely to the pyrometers supplied to them for examination by Messrs. Siemens Brothers, and that they have consequently no bearing on the question of the trustworthiness or accuracy of the platinum resistance thermometers of the kind devised by Messrs. Griffiths and Callendar."

Electric Lighting at Derry.—The electrical engineer's report contains a rather lengthy list of occasions upon which the electric cables have fused and been cut and repaired. The councillors are naturally grumbling about the matter, and a report is to be prepared by Mr. Blake.

British Exhibitors and the Chicago Exhibition.—The firms on this side of the Atlantic which sent goods for exhibition at the World's Fair, have just given an expression to their feelings regarding the official administration of the British section in a letter signed by 105 of them, addressed to the Home Secretary. This letter was sent for the purpose of notifying their appreciation of the efforts of the British Royal Commission and the British members of the international jury, but they have considered it a fitting opportunity to express also their dissatisfaction at the negligent manner in which affairs for their special section were administered by the Exhibition potentates. They firstly complain of the inconvenience and annoyance caused on account of the executive officer of the British department and his assistant not being sufficiently in touch with British exhibitors. The want of headquarters for foreign exhibitors, and the lack of decoration in the British, as compared with other departments, are also sore points with these 105 firms, who end their letter by saying that "exhibitors, especially in the general manufactures buildings, were, in the matter of decoration, placed at a great and most damaging disadvantage compared to every other nation exhibiting. We believe that, unless reforms be made in the three matters referred to, the manufacturers of this country will scarcely be induced to participate worthily at future international exhibitions." We venture to believe that few of the exhibitors from this side have gained much advantage of any kind whatsoever by placing their manufactures on show at Chicago, unless it be experience as to the ways of American officialism in exhibition matters. Britishers doubtless will know better what to do, or what not to do, in the future.

A Seventeenth Century Telephone.—An American contemporary relates in a recent issue an interesting point which, we believe, is not generally known. A German novelist of the seventeenth century, J. C. Von Grimmelshausen, in one of his celebrated works, mentions an instrument for the transmission of sound to a very considerable distance, which corresponds to that described in 1667 by the English physicist, Robert Hooke. Grimmelshausen's description is asserted to lead to the assumption of the existence of a contrivance at the time of the Thirty Years' War, very similar to our present telephone. The passage from the book reads literally as follows:—"I was, as already mentioned, so eager to gain honour and renown, that I could not sleep while all this was passing through my head. And when I had such fancies, and lay awake many a night thinking how I might contrive new finds and stratagems, I had very curious notions; consequently I bethought myself of an instrument with which I could on a calm night hear a trumpet being blown at three hours' distance, and a horse neighing and a dog barking at two hours', and a man talking at one hour's distance. In the daytime the instrument was not so useful to me unless it were in a quiet place, because one would have heard the horses and the cattle down to the least bird in the air, or frog in the water, all together, so that one would not have understood one in consequence of the noise of the other. Now I know quite well that there are people at this very hour who would not believe me; but, whether they believe me or not, it is the truth. I undertake, by means of an instrument invented by me, to recognise at night by his voice a man who does not speak louder than his usual custom. And no one would believe me of those who saw with their own eyes how I used the aforesaid instrument, and when I said to them, 'I hear horsemen galloping, for the horses are shod,' or 'I hear peasants, for the men go barefooted;' then, 'there goes a herd of cattle, for I hear sheep bleating, bulls bellowing, and pigs grunting, and so forth.' My own comrades at first took these speeches for 'fibs,' but when they found in reality that I was always speaking the truth, then they called it witchcraft taught me secretly by the devil's own mother. I am of opinion that if I had taught this science openly I should have become very popular, because it would have proved of great advantage to those engaged in war, especially in sieges."

Paper Telegraph Poles.—A New York contemporary states that paper telegraph poles are the latest development of the art. These poles are made of paper pulp, in which borax, tallow, &c., are mixed in small quantities. The pulp is cast in a mould, with a core in the centre, forming a hollow rod of the desired length, the cross pieces being held by key-shaped wooden pieces driven in on either side of the pole. Many advantages are claimed for them.

A Continuous Short Circuit.—A correspondent of the *Electrical World* cites a peculiar case of short circuiting which recently occurred on one of the circuits of an electric lighting company. The fuses in the station were blown just after a violent stroke of lightning, and the superintendent upon testing found that there was a dead short circuit. After examining a number of converters it was found that the lightning had entered one of these, passed to one of the counter-sunk screws in the porcelain fuse block, and through the cement with which the counter-bore was plugged to the casing of the converter, and the arc thus established had fused the screw head to the iron casing of the block, causing the short circuit. The primary fuses were not blown.

The Wilson Tariff Bill and British Trade.—We recommend to our readers' attention a capital article appearing in Wednesday's issue of *Money*, dealing in a most exhaustive and interesting manner with the prospects that have already opened, and are still opening out, for the various branches of the iron, steel, tin, &c., industries of this country, now that reductions have taken place in the duty on so many articles coming within the compass of these trades. According to the writer, the current of business in some parts of this country has already shown quite remarkable signs of revival through American orders, and it is to be hoped that although the Bill does not in a very large degree affect for good or evil the electrical industry, it will eventually have indirectly a beneficial effect upon the pockets and spirits of electrical manufacturers.

Thermometers for High Temperatures.—The ordinary mercury thermometer may be taken as giving accurate values up to temperatures of about 250° C. When the thermometer tube above the mercury is filled with nitrogen under pressure, readings are possible up to 450° C. Mr. W. Niehl submitted models of high temperature thermometers to the Physikalish Technische Reichsanstalt at Charlottenburg in 1893. These were capable, says *Industries and Iron*, of giving accurate readings up to 550° C., and since that time several minor constructive details have been improved, so as to yield a much more perfect instrument. The first requirement is a glass which does not soften under 600° C. For this purpose the boro-silicate glass of Jena was chosen, and it has been found very suitable. The graduation is directly marked on the tube, and may be either 180° to 550° in single degrees, or from 100° to 550° with five degree markings. In preparing the instrument the tube is filled partially with mercury and completely with carbonic acid gas, under a pressure of 300 lbs. The tube is then heated and graduated, being afterwards emptied, so that the scale can be enamelled. In the latter process an artificial ageing of the thermometer takes place, and this, to a great extent, removes the tendency of the instrument to give too high readings as time goes on. From experiment it has been found that thermometers, which in ordinary use show a rise of 8° to 10° on a scale of 360°, did not rise more than 0·6° to 0·8° when heated to a temperature of between 340° and 350° after the seasoning process. A similar result was obtained with instruments reading up to 400°, and others going up to 550°. Instruments graduated to 550°, which had not been treated, showed, after 10 hours' heating, a rise of 16° to 19°, and a further rise of from 4° to 6° when submitted to the maximum temperature for a second period of 10 hours. In thermometers of the ordinary pattern, and for moderate temperatures, a slip of enamelled glass is often inserted behind the scale, so as to make the readings of the divisions an easy matter. In high temperature instruments, however, this is not possible, owing to the difference in the expansion coefficients; but an excellent substitute is introduced by the use of a simple coating of enamel, fused upon the surface of the tube at the same time as the scale is produced, and neither the scale graduation nor the enamel at the back of the tube is affected by prolonged exposure to high temperatures.

Winchester Ratepayers Protest.—As we stated a week or two ago, a provisional order is to be applied for by the Corporation. The ratepayers, ever on the alert to crush any new scheme which has an unprofitable appearance when first proposed—however brilliant may be the future prospects—intend gathering in meeting in order that they may say as many bad things as possible about the electric light, and pass their vote in opposition to any scheme which shall light the public thoroughfares better, and give them a more cheerful appearance than does the present old-fashioned system of oil lamps. When will the Winchester public enter the van of progress? Oil lamps for street lighting at Winchester in 1894!

The Blackening of Walls by Straight Current Conductors.—Electric light engineers in the States have long known the fact that a direct current conductor, when attached to a white wall, will soon produce a dark strip on the wall. Several explanations of the cause of the discolouration have been offered, but it was left, says our trans-Atlantic namesake, to the ingenuity of G. A. Nellis to point out the facts of the case. His statement is as follows:—

> Whenever a straight current passes through a conductor it creates all around it a magnetic field of a given intensity. This field affects the circumambient air, which principally consists of two gases—oxygen, being strongly magnetic, and nitrogen, a well-known diamagnetic gas. By the attraction of oxygen a great many solid particles suspended in the air are drawn to the conductor and deposited upon it, while on account of the diamagnetic quality of nitrogen another large number of particles are repelled and hurled against the walls, where they form a black deposit.

Of course, says our New York Exchange, this phenomenon takes place only with direct current conductors. Using the alternating current no such deposit can be observed, and thus the discolouration of a wall to which a conductor is attached is at once an indication of the character of the current passing through the wire, Mr. Nellis lays great stress upon the advantage which in this respect the alternating current has over the direct current. especially for lighting private residences.

International Courtesy.—Prof. O. J. Lodge has written a letter on this subject to *Nature* explaining away certain misapprehensions which at present appear to exist in the mind of German physical philosophers regarding several expressions employed in the first edition of his book on "Modern Views of Electricity." His attention was drawn to the unintentional offence by the speech of Prof. Ludwig Boltzmann, in Section A of the B.A., the other day, and also by some Englishmen well acquainted with German Universities. "These remarks," he says, "do not occur in the second edition, but mere silent withdrawal of them does not convey the information that I desire to convey to my illustrious leaders and *confrères* in the foreign scientific world. I therefore request you to permit me space to make the following *amende*. When I said that the four great names in connection with our partial knowledge of the nature of electricity were (excluding living persons) Franklin, Cavendish, Faraday, and Maxwell, I ought to have interpolated the adjective *British* before the word 'names,' in order to avoid entering upon much larger questions than were at all appropriate to the expository course of lectures on which the book 'Modern Views' was based. The second remark was this:—When emphasising the great achievements of Hertz, in my lecture at the Royal Institution on 'The Discharge of a Leyden Jar' (reprinted as appendix to the same book), I spoke of him as 'no ordinary German.' Literally of course it is true, but it may easily be interpreted in a discourteous sense. It was, however, less widely known then than it is now that Hertz was a German savant of the highest type, and this fact I wanted to express; but if the proverbial odiousness of implied comparisons had only happened to strike me, I would certainly have altered the mode of expression before any reprints of my lecture were made. Prof. Boltzmann seems to think that the context to this remark indicates that some rancour was felt in this country that the fruits of Maxwell's theory should have been reaped by a German. That, if true, would be a serious accusation, but I can assure him that it is conspicuously untrue. To an Englishman my words would not even convey the impression. I honestly think that at the present era no trace of international jealousy exists among English and Irish physicists."

The Electrical Repulsion of Solutions.—If an attempt be made to pass a current of electricity through arsenious sulphide solution, for example, the sulphide will be repelled as a whole from the negative electrode, and also to a certain extent from the positive electrode, without appreciable electrolysis. This fact was observed a year or so ago by S. E. Linder and H. Picton in an investigation on "Solution and Pseudo-solution," which we noticed in this paper. They have now examined a large number of different solutions showing characteristic electrical repulsions. Thus aniline blue is repelled from the negative electrode, magdala red and methyl violet from the positive; sulphur and iodine from the negative electrode. It seems impossible to obtain repulsion in an absolutely non-conducting medium; for instance, iodine in carbon disulphide is not repelled. Again, in doubling the strength of arsenious sulphide, the rate of repulsion is approximately halved. Indigo in water is repelled from the negative electrode, in naphtha it is not repelled. It was found that, in general, when solutions exhibiting opposite repulsions are mixed, complete coagulation of the dissolved substance occurs. Under certain conditions of dilution the coagulation may be avoided, and the aggregates of this mixture are repelled as a whole from one electrode. By adding a new solvent the mixture is caused to be dissociated, and the aggregates are repelled individually from their characteristic electrodes. Such are some of the results obtained up to the present. More are to follow, and as some of the best scientists have expressed their interest in the particular line of research which is being followed, it is reasonable to expect that there will be some valuable conclusions drawn from it, which cannot but throw some light upon the relations existing between chemical affinity and what, for want of a better term, we call "electricity."

Electric Lighting at Manchester Main Drainage Works.—Mr. Wm. Thomas Olive recently read a paper before the Institution of Mechanical Engineers, describing "The Manchester Main Drainage Works," and gave the following particulars of the electric lighting installation:—"The installation includes a vertical engine with 13-inch cylinder and 16-inch stroke, to run at 130 revolutions per minutes, with a pressure of 80 lbs. per square inch, the steam being supplied from the general service boilers. Also a set of 56 storage batteries capable of running with lamps of 16 C.P. a maximum of 420 lamp hours. The dynamo is driven at a speed of 700 revolutions by a 10-inch flexible centre belt direct from the engine fly-wheel, which is 5½ feet diameter and 11½ inches wide on the face; it is of the inverted magnet type, compound wound, and has a capacity for working a 220-ampère load at 100 volts when on the lamp circuits. When charging accumulators a plug switch is inserted in the series portion of the compound winding, which cuts that part out of action. For charging the accumulators in series the speed of the dynamo would require to be nearly 1,000 revolutions per minute, with a corresponding increase in speed of engine. As this, however, would materially increase the wear and tear, the batteries, by means of suitable switches, are arranged in two sets of 28 each when charging. By this means the speed is reduced to about 600 revolutions per minute, thereby effecting also a saving of steam. Although storage batteries usefully yield only about 70 per cent. of the energy given to them by the dynamo, they are extremely economical and handy. If a small number of lamps only are required, it would be wasteful to run the engines; besides which, time would be occupied in oiling and heating up, and there would be loss by condensation. From the accumulators the lamps can be started or stopped instantly without any further attention. As the insulated cables spread for hundreds of yards in every direction about the premises, the stored energy could be applied on an emergency to portable machines for pumping, drilling, hauling, &c. The number of lamps at present in use is 134, as follows:—14 arcs of 1,200 C.P. for outside use, 12 arcs of 500 C.P. for inside use, 88 incandescent lamps of 16 C.P. for inside use, eight incandescent lamps of 50 C.P. on the approach road, and 12 incandescent lamps of 32 C.P. in the subway. These are divided on the switchboard into six main circuits, but there are also local switches for every one or two lamps, except on the approach road, where all the lamps are controlled by one switch."

Durban and Electric Lighting.—The Town Council have decided to obtain the "best advice in England" on a general scheme for lighting the borough by electricity. Steps are to be taken at once to carry out the details and engage the necessary assistance.

Yarmouth Electric Lighting.—The price to be charged per unit is 6d., which the engineer consulted (Mr. W. H. Preece) asserts is equivalent to 3s. per 1,000 cubic feet of gas. Mr. A. W. Ranken has been appointed clerk of the works on Mr. Preece's recommendation.

Chicago Telephone Service.—An article in our namesake hailing from across the Atlantic gives the following, among other details, regarding the telephone service at Chicago:—To provide for the necessary service mains there are 48 miles of subway with 800 manholes, 22,000 miles of wire in cables, and 8,000 miles of wire on poles in outlying districts, a plant outside of the offices requiring the services of nearly 500 men for its proper maintenance and inspection. In the main exchange office 5,400 lines extend through a great multiple board, in which are located 172,800 line spring-jacks, 7,200 trunk spring-jacks, 5,400 annunciator drops, 2,400 plugs and cords, 1,200 cord keys, 1,000 call wire keys, besides visual and lamp signals, relays, storage batteries, dynamos, and many other intricate detail parts which go to make up modern telephone switching appliances. When one realises that to each spring-jack four wire terminals are soldered, making 720,000 such terminals in the main office alone, the magnitude of the detail switchboard work will be appreciated.

United States Government Test of Wire Cables.—Lieut-Commander Duncan Kennedy, of the U.S. Navy, a distinguished electrical authority, has written a report on his method of testing cables as applied to a specimen of double conductor cable manufactured by the National India-Rubber Company, of Bristol, Conn., which most successfully withstood the test applied. After one month's immersion in salt water, so says the *Electrical World*, the cable was tested for insulation, and found to have a resistance of 2,270 megohms per knot. It was then further tested by cutting off about 10 feet, and after putting knots and kinks in it, and twisting up tight, a 500-lb. weight was attached to the end. In one kink the outside braiding was torn, but it was impossible to tear it again, though it was particularly tried. After this handling the same piece was put in a barrel of water and tested for continuity and leaks. No injury seemed to have been done to the wires or insulation. The copper wires were found to be tough and pliable, and the tinning well done.

The Cost of an Indicated Horse-Power.—An interesting paper under this title was submitted at the recent Montreal meeting of the American Society of Mechanical Engineers by De Courcy May, who summarised his subject in the following table, showing the total cost of 1 I.H.P. per annum for various engines:—

Kind of engine.	365 days of 24 hours. Coal per 2,240 lbs.					308 days of 10½ hours. Coal per 2,240 lbs.			
	£ 2	£ 3	£ 4	£ 5		£ 2	£ 3	£ 4	£ 5
Triple-expansion, pumping, Allis, 20 revs.	48	55	61	67	...	31	33	35	37
Triple-expansion, without pumps, Allis, 50 revs. ...	27	33	39	45	...	16	18	20	22
Compound mill, best engine	29	36	44	51	...	17	19	21	24
" " average ...	39	46	52	28	...	22	25	28	30
" electric light average ...	122	139	159	174	...	78	84	90	96
" trolley ...	48	58	68	79	...	29	32	36	39
Triple-expansion trolley ...	45	54	64	74	...	26	29	33	36
Condensing mill	45	52	61	69	...	25	24	33	38
Non-condensing, 50 to 200 horse-power	70	76	81	88	...	49	53	57	60

The figures for engines below 50 H.P. vary so widely that they have been omitted. The above table has been calculated, says New York *Electricity*, as far as possible from actual engines running under ordinary conditions, but it is not pretended that the figures represent true average values, the writer not having been able to collect information from a sufficient number of cases. The engines are nearly all high-class and of large powers; the figures in the table are therefore rather below than above the average.

The Association of Edison Illuminating Companies.—The convention of the Association of Edison Illuminating Companies was held at Boston, Mass., commencing on Tuesday, August 14th, 1894, and continuing during the two following days. Reports of committees chosen at the meetings of last year were made, and the following papers of practical importance submitted:—"Incandescent Lamps," Mr. A. D. Page; "The Relative Advantages of Direct and Alternating Currents for Distribution of Light and Power," Mr. W. S. R. Emmet; "A Board of Control," Prof. Wm. D. Marks; "An Edison Station in a Small City—Its Past, Present and Future," Mr. M. A. Beal; "Switchboard of the Edison Company, of New York," Mr. J. Van Vleck; "Storage Batteries," Mr. R. R. Bowker; "Boiler Tests in Atlantic Avenue Station of the Edison Electric Illuminating Company, of Boston," R. S. Hale; "Interesting Features of the Third District Station of the Edison Electric Illuminating Company, of Boston," A. G. Pierce; "Low Tension Arc Street Lighting System," Mr. W. S. Barstow.

Dielectric Constants and Chemical Equilibrium.—As the energy of an electrically-charged system is lowered when the latter is placed in a medium of higher dielectric capacity, there is on this account an attractive force on electric points towards the medium possessing the higher capacity. From this standpoint W. Nernst, by considering the ions as electrically-charged points, has recently deduced that the greater the dielectric constant of any given medium, the greater will be the electric dissociation of a substance dissolved in it. Although this is a piece of purely theoretical deduction, all the known facts, which are, unfortunately, few, completely support this view. Gases of dielectric constants $\kappa = 1{\cdot}0$ undergo no electric dissociation at ordinary temperatures. Benzene, $\kappa = 2{\cdot}3$, exhibits very slight traces; with alcohol, $\kappa = 25{\cdot}0$, the dissociation is distinct, whilst in the case of water, $\kappa = 80{\cdot}0$, the electric dissociation is very strong. Experiments also with a number of other substances gave electric dissociations in accordance with the value of their dielectric capacities. Many organic acids contain "molecular complexes," which decompose first into simple molecules and then into ions. Nernst is of opinion that their decomposition will be found to follow the same law. Reference is made to the measurements of Eijkman and Beckmann; but for details the original paper must be consulted (*vide Zeitschrift für Physikalische Chemie*, xiii., pp. 531—536).

New Substances from the Electric Furnace.—As was anticipated, the electric furnace, which can now be so easily manipulated, has rendered possible the synthetic formation of many new substances, some of which will doubtless be found to possess commercial value. Mons. H. Moissan, whose indefatigable and successful attempts to bring this type of furnace into practical use we have frequently remarked, has recently been demonstrating its value as a means of producing substances which have hitherto baffled all ordinary chemical processes. Amongst these we may notice calcium carbide (*vide Comptes Rendus*, cxviii., pp. 501—506), barium and strontium carbides (*vide Comptes Rendus*, cxviii., pp. 683—686), and carbon boride (*vide Comptes Rendus*, cxviii., pp. 556—560. The first of these is produced by placing an intimate mixture of lime and carbon in the crucible of the electric furnace, and subjecting it to the action of a current of 350 ampères and 70 volts for 15 or 20 minutes. The same current serves for the production of barium or strontium carbide, the mixture used being baryta or strontia with carbon. Carbon boride is formed when the electric arc is allowed to pass between two carbons agglomerated by means of a solution of boric acid and aluminium silicate; or when boron is placed in the arc, or by the action of the current upon a mixture of amorphous boron and carbon. The last named process requires a current of 250—300 ampéres and 70 volts applied for six or seven minutes. The success of these operations appear largely to depend upon the employment of carbon that has been obtained from the ignition of sugar. There is no doubt that at least one of these substances will find immediate commercial application, for carbon boride, although very friable, is also very hard, and in spite of its being slightly softer than diamond, it can be used very successfully for polishing and cutting these stones.

An Eastern Tour.—The steamer *Electra*, belonging to the Eastern Telegraph Company, arrived in the Bosphorus on Tuesday from the Black Sea, with a distinguished company, including Lord Wolseley, the American Ambassador in London, Sir Evelyn Wood, Sir John Pender, and others.

Personal.—Lord Kelvin is nominating Mr. Charles Bright, C.E., to fellowship of the Royal Society of Edinburgh. Lord Kelvin and the late Sir Charles Bright, father of the present nominee, were shipmates in the vessel which laid the old Atlantic cable. Mr. Bright's qualifications as an electrician, and in cable matters, are very numerous.

Electrical Standards.—The issue of an Order in Council, approved by Her Majesty the Queen on the 23rd inst, has legalised the ohm, volt and ampére for "steady unvarying currents," as can be seen in our other pages. We had hoped to have dealt with some of the points raised by the wording and form in which the Order in Council is framed this week, but owing to pressure on our space this article must be withheld to our next issue, when we hope to discuss the position of legal electrical standard units as constituted by the aforementioned order.

A Social Pleasantry.—Under the heading of "The Argus Letters" in the Beckenham *Advertiser*, there is a choice example of the would-be oracle. He declares that an electric spark smells offensively, and ravingly asserts that it is beyond the bounds of ordinary toleration that the lawn tennis players of the neighbourhood should be scared from healthy recreation and social pleasantries by the unpleasant presence of *electric vapour*. The Crystal Palace District Electric Supply Company has had enough to contend against, without having to endure the fresh odium of supplying offensive *electric vapour!* Surely this must be a "Social pleasantry?"

Metallic Film Formation.—During the electrolysis of a concentrated solution of zinc sulphate, it was recently observed by F. Mylius and O. Fromm, to whose researches in this direction we have several times called attention, it was observed that the cathode wire became surrounded by a film of metallic zinc, floating upon the surface of the solution, which gradually increased until it attained a considerable size. A somewhat similar observation was once made by F. Kohlrausch during the electrolysis of silver chloride in an alkaline solution. The phenomena have consequently been investigated by Mylius and Fromm, and their results form the subject of a contribution to the *Annalen der Physik und Chemie* [2], li., pp. 593—621. Their observations lead them to the conclusion that the formation of floating metallic films during electrolysis is conditioned chiefly by an impure state of the surface of the solution, and by the presence of oxygen in the atmosphere above the solution. If these conditions are absent, the films do not appear; thus, if the air above the surface is replaced by hydrogen or other gas containing no oxygen, and the surface is freed from impurity, no films are formed. By eliminating these conditions, *i.e.*, by allowing air to have access to the surface, and by soiling the surface with a trace of oily impurity, films can be obtained from copper, cadmium, cobalt, iron, and antimony solutions. It is not clear that this observation can be applied to practical commercial use, but, remembering the many surprises which have been sprung upon us in connection with electrolysis, it is well to chronicle and bear in mind any result which has been obtained by careful observation.

NEW COMPANIES REGISTERED.

Lynton and Lynmouth Electric Light Company Limited (41,835).—This company was registered on the 27th ult. with a capital of £8,000 in £1 shares (1,000 preference and 7,000 ordinary) to acquire and carry on the electric lighting business now carried on at Lynton and Lynmouth, Devon, under the style of the Lynton and Lynmouth Electric Light Company; and to carry on the business of an electric light company. The subscribers (with one share each) are:—H. E. Brougham, 67, Sherrard road,

Forest Gate, shorthand writer; C. J. Fox, 7, Great St. Thomas Apostle, Queen Street, E.C., solicitor; C. Green, Hillside, Okehampton, surveyor: J. H. Benn, 27, Clement's Lane, E.C., merchant; H. S. Miller, 43, Clapton Common, N.E., clerk; W. J. Langstaff, 12, Wickham Gardens, S.E., clerk; H. H. Benn, 4, Montpelier Square, S.W., electrical engineer. Table A mostly applies. Registered office, The Electric Light Works, Lynmouth, North Devon.

Saycee Electrical Syndicate, Limited (41,810).—This company was registered on the 22nd inst., with a capital of £10,000, in £1 shares (9,500 ordinary and 500 deferred), to purchase patent rights for "Improvements relating to primary batteries;" for "Improvements in primary batteries," and for "Improvements in primary batteries and the depolariser used therein," and to work and develop the above-named inventions. The subscribers (with 1 share each) are:—H. Hall, 106, Shakespeare Road, Stoke Newington, N., clerk; C. W. Bloomfield, 24, Essex Road, W., clerk; F. Chipperfield, 304, Southampton Street, S.E., clerk; R. Paris, 8, Chestnut Road, S.E., merchant's clerk; H. M. Bentley, Friern Park, North Finchley, secretary; W. H. Rumball, 139, Park Road, Crouch End, accountant's clerk; G. M. Gordon, Broad Street House, E.C., accountant. There are not to be more than seven directors. Qualification, £100; remuneration to be fixed in general meeting. Registered by J. R. Pakeman, 20, Bucklersbury, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Chelsea Electricity Supply Company, Limited (20,468).—This company's annual return has been lately filed. It shows that out of a nominal capital of £100,500 in 14,000 ordinary and 6,000 preference shares, all of £5 each, and 500 founders' shares of £1 each, 10,277 ordinary and 500 founders' shares have been taken up. A sum of £5 has been called on 3,611 shares; £18,055 has been received; and £33,830 has been agreed to be considered as paid.

Charles Churchill & Co., Limited (29,931).—This company's last yearly return shows that out of a nominal capital of £6,000, in 140 £25 preference and 50 £50 ordinary shares, 103 preference and 40 ordinary shares have been taken up. A sum of £25 has been called up on each of the preference shares; £1,325 has been received, and £3,750 has been agreed to be considered as paid.

Norwich Electricity Company, Limited (30,694).—This company's yearly return has lately been filed. It shows that out of a nominal capital of £50,000, in £10 shares, 2,382 shares have been taken up, and that the full amount has been called on each. A sum of £23,752 10s. has been received, and £67 10s. is outstanding.

BUSINESS NOTICES, &c.

Electric Traction in Ireland.—Our readers have from time to time observed that a project has been set on foot for superseding the old system of horse traction on the lines of the Dublin Southern District Tramway by introducing electricity, and powers to this end have been granted by Parliament. Since the sanction was received to their application the directors have devoted their attention to the task of arranging the best method in which so extensive and expensive an alteration can be effected. The entire length of the line that will thus be changed is eight miles, the line running between Dublin and Dalkey. The directors have lately entered into a contract with the British Thomson-Houston, Limited (late Laing, Wharton & Down Construction Syndicate), who have undertaken to carry out the work at a total cost of £70,000 for laying the double line, rearranging the present terminal depôt as a power station, and equipping the line with an overhead conductor system and motor cars. It has been found necessary to double the present capital of the Tramway Company. On the total capital of £140,000—half of which now issued bears preferential charges, the other half being represented by the ordinary shares—it is confidently expected, says a contemporary, that profitable dividends will be paid, owing to the greatly diminished working expenditure and the correspondingly increased receipts due to a quicker and more frequent through service. Those engaged in the work propose themselves to find all the debenture or preferential capital, thus showing their faith in the future of the concern; the Imperial Tramway Company will contribute £10,000 in cash and the contractors offer the balance. If there are many such contracts entered into in the Emerald Isle Paddy should ere long be able to purchase horses at break-up prices, unless Messrs. Barber & Co., are allowed to step in at their usual break-up charge.

Price Lists, &c.—The Chloride Electrical Storage Syndicate, Limited, have sent us a price list of their traction cells of the special protected type. This list is accompanied by a copy of a testimonial received from the Inter-Colonial Railway of Canada, testifying to the durability of the accumulator.

From the Rhode Island Braiding Machine Company we have received two pamphlets, illustrating and describing their braiders and accessories.

Messrs. Moeller & Condrup, of Fore Street, have brought out a list of paraffin gas apparatus supplied by them. The "Aetna" paraffin blow lamp for electrical engineers is among the apparatus supplied. They also describe in this list their pipe cutters, pipe wrenchers, spanners, &c.

From the Royal Electric Company of Peoria, Ill., we have received a list of their dynamos, motors, and electric supplies.

Messrs. Robey & Co., Limited, have brought out a catalogue of their improved patent oil engines. The company claim that their engines are specially adapted for driving motors for electric lighting, because of their economy and steady running. The engines are illustrated in the list, and prices and a telegraph code are also included. The "Robey" portable oil engine has a full page illustration.

Meldrum's Improved Furnace.—In our issue of September 8th, 1893, in describing this furnace, we called attention to its merits in connection with electric lighting stations, instancing the application of the system at the West Brompton Station of the House-to-House Electric Light Supply Company, the works of the City of London Electric Light Company, and elsewhere. We learn that rapid progress is being made with the introduction of the furnace as a necessary adjunct to such installations, especially where a varying demand exists for steam, as by its means the fire can be forced or retarded at will. Electric lighting being now largely in the hands of corporations and local boards, the apparatus is much appreciated as affording a means of utilising the refuse fuel from gas works, furnaces having been ordered with this object for several places, notably Bolton (6), Stafford (6), and Islington (10). With the assistance of the forced draught afforded by the Meldrum furnace, even town refuse can with advantage be utilised for electric lighting purposes, a practical illustration of which will shortly be afforded at Rochdale, Salford, Eccles, Crewe, and Basingstoke; also, town refuse is made use of for steam raising in connection with pumping stations and other works.

Electric Lighting of County Council Buildings.—In further reference to our "Business Notice" on this subject last week, we now learn that the Hants County Council have decided to introduce the electric light wires into the new county buildings, but have not yet settled upon a complete installation. The cost of the wires, irrespective of fittings, will be about £187. In the event of there being eventually a public supply in Winchester of electric current, the council will be connected with the street mains, thus avoiding the necessity for a special plant; when required, the brackets, pendants, &c., are estimated to cost £138. In the meantime, however, only the wires are to be fitted, as the Winchester Authorities have not yet come to any decision as to what shall be done in the question of supplying the town. Should the county council decide later on to put down a separate plant, the additional cost above wiring and fittings is estimated at about £500.

Bankruptcy.—At the London Bankruptcy Court last Tuesday, the first meeting of creditors was held before Mr. C. A. Pope, Assistant-Receiver, under the failure of Arthur Shippey, electrical engineer, 13, King Street, Cheapside. Accounts have been filed showing unsecured creditors £1,170 1s. 10d., and assets showing an estimated surplus of £5,473 8s. 4d., subject to realisation at the debtor's value. The debtor also claims to be entitled to a sum of £500 from Grenfell & Acle, Limited, of Birmingham, in connection with an electrical battery company about to be formed. He stated, in reply to the chairman, that the said company had not yet gone to allotment, and he understood no capital had yet been subscribed. Although he had expressed an intention of making an offer to the creditors, he was not yet in a position to lay it before them. In the absence of a quorum, the meeting was adjourned for three weeks.

Electric Lighting in Whitechapel.—With the aid of Prof. Robinson, the Streets Committee of the Whitechapel District Board of Works have submitted a report regarding the proposed electric lighting. The first scheme for lighting the prescribed area was estimated to cost £52,300; three alternative schemes were afterwards submitted, the total capital outlay being respectively £72,250, £74,750, and £84,250. The proposed charge per unit is said to be 5d. per unit. The Whitechapel destructor premises are recommended as suitable for the station, the present waste heat of the furnaces being utilised for generating purposes. The Board's consideration of the matter has been adjourned until next October.

Frank Suter & Co.—This firm are now carrying out the complete installation of Messrs. P. & D. Colnaghi & Co.'s Galleries, 13 and 14, Pall Mall East, S.W., complete installation for Mr. J. B. Carrington, 14, Netherhall Gardens, Hampstead; also a complete installation at 29, Fitzjohn's Avenue, for Mr. J. E. Abrahams, as well as numerous other contracts in town and country, including the lighting of a tennis court for evening play for George Newnes, Esq., M.P., and picture lighting for W. Cuthbert Quilter, Esq., M.P.

Blackburn Art Gallery.—Messrs. Frank Suter & Co. write us as follows:—"We notice a paragraph in your last issue stating that Messrs. Berry & Pope have obtained the contract for lighting the above gallery, which is correct. At the same time, we shall be glad if you will mention in your next issue that the consulting engineer, Mr. W. Leake, of 30, Victoria Buildings, Manchester, specified Frank Suter & Co.'s registered picture lighting reflectors for this gallery, and that the same are being used."

Johnson & Phillips.—This firm are at present very busy with numerous large orders in their cable department, more especially in their India-rubber shops, upon the manufacture of house wiring cables and wires. Of the latter, however, very few are now used, as the majority of engineers specify that only stranded conductors may be employed on the works. At this time of the year Messrs. Johnson and Phillips are usually somewhat quiet with this class of work.

Electric Lighting of Hertford.—The Lighting Committee have drawn up a report recommending to the Corporation that the proposed electric lighting scheme be carried out as speedily as possible; that the engineer be instructed, with the assistance of the borough surveyor, to prepare the detailed plans for carrying out the scheme, and the requisite forms of tender; and that application be made to the Local Government Board for power to borrow £6,000.

Rashleigh Phipps & Co.—This firm, of 102, Oxford Street, has recently fitted up a large number of installations for Colonel Edis, architect, of Fitzroy Square, and has now been entrusted with the lighting of his house throughout. This firm has also received a contract for the whole of the fittings for the new conservative club in Glasgow. The Hon. Percy Allsopp, of Park Street, has also entrusted the lighting of his house to this firm.

Inspection of Cattle by the Aid of Electric Light.—The Great Northern Railway have arranged for an installation of the electric light at Belfast for the inspection of cattle after sunset during the winter months. This will enable dealers to send their cattle down to the departing steamers by later trains, instead of as at present having to keep them down by the harbour for some hours beforehand.

Electric Light at Warminster.—With regard to the extension of the electric light in the town, the committee appointed to consider the question, has recommended that the electric light should be extended to the top of Town Hall Hill by the erection of three additional arc lamps. The consideration of the matter has been adjourned for some days.

Elmore.—A financial contemporary states that Elmore's Patent Copper Depositing Company, Limited, has been officially notified by the Director of Army Contracts, that its name has been placed upon the list of contractors to the War Department, as a result of tests made upon Elmore copper, which has been approved by the Government.

Are You Troubled with Blow Holes?—This is the title of a card published by the Billings & Spencer Co., of Hartford, Conn., to which is attached one of Billings's patent commutator bars, which are drop-forged from pure, unalloyed wrought copper, and asserted to be free from blow holes, porosity, and all imperfections.

Annual Outing.—The employés of Roger Dawson, Limited, went for their annual outing last Saturday. The party, which numbered close upon 100, journeyed by early morning train to Portsmouth, where dinner was served at the Sussex Hotel. We understand that the firm is at present very busy.

Constantia Incandescent Lamps.—Under the management of Mr. W. Conze, an office is now open at 37, Queen Victoria Street, E.C., for the lamps made by the enterprising proprietors of the Constantia Incandescent Lamp Manufactory, Venlo, Holland.

Warehouse Lighting.—Messrs. Copland & Lye are having their warehouses extended in Sauchiehall Street, Glasgow. Among the improvements will be the installation of the electric light and a lift worked by electricity.

French Customs' Duties.—It has recently been decided by the French Customs Authorities that supports for incandescent lamps composed of copper and porcelain, are to pay a duty of 75 francs per 100 kilogrammes.

Civil Service Supply Association.—The chairman, at the meeting last Tuesday, said that "the directors had laid down electric lighting engines, and that a great saving had been effected in the consumption of gas."

Bazaar Lighting.—Preparations are being made at Otley for a bazaar in aid of the new Science and Art Schools. The electric lighting installation is being laid down by Messrs. Rosling and Matthews, of Bradford.

Electric Light at Newport.—Enquiries are being made *re* proposed electric lighting of the Free Library, and the assistant electrician (Mr. Copland) has undertaken to prepare plan and estimate.

Halifax Electric Lighting.—The Corporation are inviting applications for the supply of electricity current for motive power purposes at 4d. per unit. 6d. per unit is the charge for lighting.

Electric Light in Leeds.—A sub-committee has been appointed to consider a proposal made by the House-to-House Electricity Company to illuminate certain public thoroughfares.

Salisbury and Electric Lighting.—Mr. Robert Hammond attended the Town Council's meeting the other day, and gave information regarding the electric lighting of the town.

Hotel Lighting.—Duckworth's Hotel, Rochdale, has been lately lighted throughout by electricity. Current is supplied by a Crompton dynamo worked by a 12 H.P. gas engine.

Dissolution of Partnership.—Messrs. Habgood and Smith, electrical engineers, of Great Missenden, have dissolved partnership. Mr. W. Habgood will settle debts.

Chesterfield and Electric Lighting.—The Town Council at its last meeting decided that it has no time at present to consider the carrying into effect of the 1894 electric lighting order.

Church Lighting.—St. Peter's Church, Eaton Square, is to be closed for some weeks, while an installation of the electric light is put in.

Julius Sax & Co.—The Strand Union officials have asked this firm to quote prices for fixing electric bells in the casual wards.

Electric Lighting in Tasmania.—It is proposed to light the Tasmanian Houses of Parliament, at Hobart, by electricity.

Electric Lighting at Dundee.—The electric light is to be extended to the police offices.

CONTRACTS OPEN AND CLOSED.

OPEN.

Cheltenham—September 8th. For the supply of junction boxes, covers, and other castings, for the Corporation. Details on application to the Borough Surveyor, Municipal Offices, Cheltenham.

Kendal—August 31st. For the supplying and fixing of telephonic communication between the gas company's offices, Parkside Road, and the borough treasurer's office, 69, Highgate, for the Kendal Urban Sanitary Authority. Particulars from Mr. D. C. Goddard, borough surveyor, 3, Bridge Street, Kendal.

Pacific Cable—November 1st. The Canadian Government invites cable manufacturing contractors and others to state the terms upon which they will be prepared to lay, and maintain in efficient condition, a submarine electric cable across the Pacific from Canada to the Australasian Colonies. Further particulars will be found among our advertisements.

Shrewsbury.—For electric light and power station at Shrewsbury. Application to be made immediately to Mr. A. E. Lloyd Oswell, architect, Dana Chambers, Shrewsbury.

Widnes—September 4th. The local authority wants tenders for the manufacture and supply of a steel Lancashire boiler, for the Corporation.

CLOSED.

Southampton—Crompton & Co.'s tender for electric lighting the Town Quay at £789, is to be accepted. Further details will be found in our "Business Notices."

CITY NOTES.

Crompton & Company, Limited.—At an extraordinary general meeting of the shareholders of this company, held at Cannon Street Hotel on Wednesday afternoon, the following resolution which was passed on Monday, August 13th, 1894, was confirmed:—"That the capital of the company be reduced from £300,000 to £280,000 by cancelling paid up capital which has been lost, or is unrepresented by available assets, to the extent of £20,000, by cancelling 4,000 ordinary fully paid up shares of the company, numbered 2,785 to 6,784, inclusive, which have been issued."

Stock Exchange Announcement.—Application has been made to the Stock Exchange Committee (1) to appoint a special settling day in, and to grant a quotation to, the National Telephone Company, Limited, scrip and fully-paid scrip of £1,100,000 3½ per cent. debenture stock.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending August 26th, 1894, amounted to £878; week ending August 27th, 1893, £719; increase, £159; total receipts for half-year, 1894, £6,942; corresponding period, 1893, £6,647; increase, £295.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending August 24th, after deducting 17 per cent. of the gross receipts payable to the London Platino Brazilian Telegraph Company, Limited, were £2,545.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1891.	1892.	1893.	Closing Quotation, August 22nd.	Closing Quotation, August 29th.	Business done during week ended August 29th, 1894. Highest.	Lowest.
184,500*l*	African Direct Teleg., Ltd., 4 % Deb.	100	...	...	...	101 —104	101 —104	103	...
1,134,640*l*	Anglo-American Teleg., Ltd.	Stock	£2 12s.	£2 15s.	£2 11s.	40 — 43	40 — 43	42	...
2,932,680*l*	Do. do. 6 % Pref.	Stock	£5 5s.	£5 10s.	£5 2s.	76 — 78	76 — 78	77½	76⅝
2,932,680*l*	Do. do. Defd.	Stock	...	...	...	6¾ — 7¼	7 — 7⅛	7¼	7⅛
130,000	Brazilian Submarine Teleg., Ltd.	10	8 % §	6½ % §	6½ % §	12½ — 13	12½ — 13	13	12 13/16
75,000*l*	Do. do. 5 %, repayable June 1906	100	...	...	...	107 —111	108 —112	109½	...
44,000	Chili Telep., Ltd., Nos. 1 to 40,000	5	... §	10% ‖ §	... §	1 — 2	1 — 2	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	7 %	139 —143	139 —143	...	...
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	3½ % §	2 % §	2 % §	⅛ — ¼	⅛ — ¼	⅛	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	12½ — 13½	12½ — 13½	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	19½ — 20½	19½ — 20½	20⅜	...
12,931	Direct Spanish Teleg., Ltd., £4 paid	5	4½ %	4 %	4 %	4 — 4½	4½ — 5	...	...
6,000	Do. do. 10 % Pref.	5	10 %	10 %	10 %	9¼ — 9⅝	9½ — 10	9 11/16	...
30,000*l*	Do. do. 4½ % Debs of £50, Nos. 1 to 1,600	...	...	...	...	103 —106%	105 —108%	...	...
60,710	Direct United States Cable, Ltd., 1877	20	3½ % §§	3½ % §§	...	8½ — 9½	8½ — 9½	8¾	...
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½ % §§	6½ % §§	...	15⅝ — 15⅞	15⅝ — 15⅞	15⅞	15 11/16
70,000	Do. 6 % Pref.	10	6 % §§	6 % §§	...	16½ — 17	16¼ — 17	16⅝	16⅜
105,900*l*	Do. 5 % Debs., repay. August, 1899	100	...	...	...	105 —109	105 —109	...	...
1,294,100*l*	Do. 4 % Mort. Deb.	Stock	...	...	...	117 —120	117 —120	118½	117
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7 %	7 %	15⅝ — 15⅞	15⅞ — 16	15 15/16	15⅝
62,700*l*	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	...	...	...	103 —106	103 —106	...	...
222,800*l*	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	...	...	...	103 —106	103 —106	...	...
320,000*l*	Do. 4 % Deb. Stock	Stock	...	...	...	115 —118	115 —118	...	...
95,100*l*	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	...	...	...	103 —106	103 —106	...	...
129,100*l*	Do. do. to bearer, 2,344 to 5,500	...	...	...	...	103 —106	103 —106	104½	104
300,000*l*	Do. 4 % Mort. Debs. Nos. 1 to 2,016, red. 1909	100	...	...	...	103 —106	103 —106	...	...
200,000*l*	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	...	...	...	108 —111%	108 —111%	...	...
180,227	Globe Telegraph and Trust, Ltd.	10	5½ % §§	4⅞ % §§	4⅞ % §§	8⅝ — 8⅞ xd	8⅞ — 9	8 15/16	8⅞
180,042	Do. do. 6 % Pref.	10	6 % §§	6 % §§	6 % §§	15½ — 16 xd	15½ — 16	16	15⅝
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅗ §	8⅗ §	8⅗ §	20 — 21	20½ — 21½	...	...
200,000*l*	Do. do. do. 5 % Debs.	100	...	...	...	105 —108	105 —108	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	10 %	45 — 47	45 — 47	46½	46¼
37,548	London Platino-Brazilian Teleg., Ltd.	10	...	...	...	5 — 7	5 — 7	...	...
100,000*l*	Do. do. 6 % Debs.	100	...	...	...	108 —111	109 —112	...	...
15,000	Monte Video Teleph. Co., Ord., 1 to 15,000	5	...	...	...	½ — 1½	¼ — ¾	...	...
28,000	Do. do. 6 % Pref., 1 to 28,000	5	...	...	...	½ — 1½	1 — 2	...	...
484,597	National Teleph., Ltd., 1 to 438,984	5	6 % §	5 % §	...	4⅞ — 5⅛	4⅜ — 5	5¼	4⅞
15,000	Do. 6 % Cum. 1st Pref.	10	...	...	...	14 — 15	14 — 15	14¾	14⅜
15,000	Do. 6 % Cum. 2nd Pref.	10	...	...	...	13½ — 14½	13½ — 14½	...	...
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 90,950	5	...	...	...	5½ — 5¾	5½ — 5¾	5⅝	...
925,017*l*	Do. 4½ % Deb. Stock Prov. Certs. ...	...	...	...	...	108 —111	108 —111	...	...
48,800	New Teleph., Ltd., 25,901 to 74,700; £4 paid	10	...	...	...	... — ...	... — ...	...	...
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	...	...	...	½ — ⅝	½ — ⅝	½	...
100,000*l*	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	...	...	...	102 —105	103 —106	104½	...
11,839	Reuter's Ltd.	8	5 %	5 %	...	3 — 5	3 — 5	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	108 —113	107 —112	108	107½
58,000	United River Plate Teleph., Ltd.	5	...	...	...	1 — 2	1 — 2	...	...
146,370*l*	Do. do. 5 % Debs.	Stock	...	...	...	85 — 95	85 — 95	...	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	4 %	..	...	3 — 5	3 — 5	...	...
249,900*l*	Do. do. do. 5 % Debs.	100	...	...	...	102 —105	102 —105	104	...
30,000	West Coast of America Teleg., Ltd.	10	...	...	...	2½ — 3	2 — 3	...	...
150,000*l*	Do. do. do. 8 % Debs., repay. 1902	100	...	...	...	99 —104	100 —105	103	102
64,242	Western and Brazilian Teleg., Ltd.	15	4 %	2½ %	5 %	6⅜ — 7¼	7 — 7⅛	7⅜	...
33,129	Do. do. do. 5 % Cum. Pref. ...	7½	...	...	...	5¾ — 6¼	6 — 6½	6 5/16	6¼
33,129	Do. do. do. 5 % Def.	7½	3 %	...	...	1⅜ — 2¼	2 — 2⅛	2⅛	...
178,200*l*	Do. do. do. 6 % Debs. "A," 1910 ...	100	...	...	...	105 —108	106 —109	...	...
222,700*l*	Do. 6 % Mort. Debs., series "B," red. Feb. 1910	100	...	...	...	105 —108	106 —109	...	...
88,321	West India and Panama Teleg., Ltd.	10	¼%	¼%	⅜%	1 — 1¼	1 — 1¼	...	...
34,563	Do. do. do. 6 % 1st Pref. ...	10	...	...	...	10¼ — 10¾	10½ — 11	10 11/16	...
4,669	Do. do. do. 6 % 2nd Pref. ...	10	...	...	...	9 — 10	9 — 10	...	...
80,000*l*	Do. do. 5 % Debs. (1917) No. 1 to 1,000	100	...	...	...	107 —110	107 —110	...	...
$1,214,000	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	...	...	...	115 —120	115 —120	...	...
169,000*l*	Do. do. 6 % Ster. Bonds.	100	...	...	...	100 —104	100 —104	...	...

ELECTRICITY SUPPLY COMPANIES.

20,510	Charing Cross and Strand Electy. Supply, 1 to 6, 215 to 718, and 10,001 to 30,000	5	...	5 %	4½ %	4½ — 5½ xd	4½ — 5½	...	...
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000	10	...	...	...	12½ — 13½	12½ — 13½	13 1/16	12⅝
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	...	6 %	6 %	14 — 14½	14 — 14½	14½	14¼
100,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	...	...	...	128 —131	128 —131	...	...
45,000	†Liverpool Electric Supply, £4 10s. paid	5	4½ %	5 %	5 %	6⅝ — 6¾	6⅝ — 6⅞	...	...
49,900	*Metropolitan Electric Supply, Ltd., 6,101 to 50,000 ...	10	1 %	2 %	2½ %	8¼ — 8⅝	8¼ — 8⅝	8 1/16	8 7/16
100,000*l*	Do. 5% Deb., 1 to 10,000 in bonds of £10, £20, £40	...	...	...	...	... — ...	... — ...	...	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	...	...	...	4¼ — 5½	4½ — 5½	...	...
19,980	St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-18,780	5	8½ %	7¼ %	4½ %	6⅞ — 7¼	7 — 7½	7 3/16	7½
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	8¼ — 8⅝	8¼ — 8⅝	8½	8 7/16
59,900	*Westminster Electric Supply Corp., Ord., 101 to 60,000 ...	5	...	3½ %	4 %	6 — 6½	6¼ — 6¾	6⅝	6⅝

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1891.	1892.	1893.	Closing Quotation, August 22nd.	Closing Quotation, August 29th.	Business done during week ended August 29th, 1894. Highest.	Lowest.
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000	3	...	6 % §	6 % §	2⅞— 3	2⅞— 3	3	2⅞
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	...	6 % §	6 % §	2¼— 2½	2¼— 2½	2 7/16	2⅜
125,000/	Do. do. 4½ % Deb.	Stock	...	...	...	110 —113	110 —113	...	...
630,000/	City and South London Railway	Stock	...	⅝%	⅝%	36 — 38 xd	36 — 38	37½	...
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	7 % §	7 % §	7 % §	1⅜— 2¼xd	1⅜— 2¼	...	...
50,000/	Do. do. 5 % 1st Mort. Debs., 1—400 of £100, and "A" 1—200 of £50 each	...	...	...	...	95 —100	95 —100	...	...
120,000	Electric Construction, Ltd., 1 to 120,000	2	...	...	...	⅛— ¾	⅛— ¾	...	...
12,845	Do. do. 7 % Cum. Pref., 1 to 12,845 ...	2	...	...	...	1¼— 1⅝	1⅝— 2	...	...
100,000	Elmore's French Patent Cop. Deposg., Ltd, 1 to 66,750 ...	2	*nil*	*nil*	*nil*	¼— ⅜	¼— ⅜	...	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil* ¶	*nil*	*nil*	1 — 1¼	1 — 1¼	...	...
67,385	Elmore's Wire Mfg., Ltd., 1 to 67,385, issued at 1 pm. ...	2	*nil*	*nil*	*nil*	¾— 1	⅞— 1⅛	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300	5	*nil* §	*nil* §	*nil* §	½— 1½	½— 1½	...	...
9,600/	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	7 %	...	...	6½— 7½	6½— 7½	...	...
6,837	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	5 %	5 %	5 %	7 — 8	7½ — 8	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	12½%	12½%	12½%	23 — 24	23 — 24	23⅞	23½
200,000	Do. do. do. 4½ % Deb., 1896	100	...	...	...	103 —105	103 —105	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	...	...	1 %	7⅛— 7⅛xd	7⅛— 7⅛	...	...
6,295	† Do. do. Pref., £8 paid	10	...	...	...	12¾— 13 xd	12¾— 13	13	...
78,949	Swan United Electric Light, Ltd., £3½ paid	5	11 % §	10 % §	7½% §	... — ...	... — ...	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	20 %	15 %	20 %	40 — 42	40 — 42	42	41½
150,000/	Do. do. do. 5 % Bonds, red. 1894	100	...	...	...	102—105	102 —105	...	...
54,000	Waterloo and City Railway, Nos. 1 to 54,000, £2 paid ...	10	...	...	...	2 — 2¼	2 — 2¼	...	...

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50% for 1890.
Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.
Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0%§; 1891—7%§; 1890—8%§.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Birmingham Electric Supply Company, Ordinary of £5 (fully paid), 5¼—5⅜.
Electric Construction Corporation, 6 % Debentures, 87—92.
Electric and General Investment, shares of £5 (£1 paid), 1¾—2¼.
Electricity Supply Corporation, Ordinary of £5, 5—5¼.
House-to-House Company (£5 paid), 1—1½.
Do. do. 7 % Preference, of £5, 5¼—5½.
Do. do. 6 % Debentures of £100, 101—103.
Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid) 4⅜—5¼; 1st Preference Cumulative 6 %, £5 (fully paid), 6¼—6⅜.
Liverpool Electric Supply, £5 (fully paid), 6⅜—6½.
Do. do. £3 10s. paid, 4½—4⅝.
London Electric Supply Corporation, £5 Ordinary, ⅞—1¼.
Queen Anne's Mansions Lighting and Heating Company, 6 % £100 Debentures, 101—103.
Yorkshire House-to-House Electricity Company, £5 Ordinary Shares (£4 10s. paid), 4¼—4⅜.

Bank rate of discount, 2 per cent. (February 22nd, 1894).

THE BRITISH ASSOCIATION.

A DIRECT-READING FORM OF PLATINUM THERMOMETER.

By G. M. Clark.

During the last few years much progress has been made in the subject of thermometry. This is more especially the case in instruments whose action is based on a change in electrical properties—such as the E.M.F. of a thermal junction, or the changes in resistance of a wire. It is to this latter class that the platinum thermometer belongs.

Whatever method of measuring temperature is adopted, the assumption may be made that the change measured is proportional to the changes in temperature. This assumption will give a scale of temperatures, depending, however, on the thermometric substance used, and which will not be the same when the thermometric substance is changed. In order to bring all such thermometric scales to a common basis, they have to be compared with the indications of the normal air thermometer.

In the case of a platinum thermometer we make the assumption that the change in resistance is proportional to temperature, and call the temperature so deduced the platinum temperature. Thus if R and R_0 are the resistance in steam at 760 mm. pressure, and ice, $R - R_0 / 100$ is the change in resistance per degree; and if R is the resistance at any other temperature the platinum temperature, $p\ t = (R - R_0) \div R - R_0 / 100$.

The relation between the platinum temperature and the air thermometer scale has been experimentally shown to be expressed by the formula

$$a = t - p\,t - \left(\frac{t}{(100)^2} - \frac{t}{(100)}\right)$$

where t is the air thermometer temperature, and p is a coefficient whose value is approximately 1·50. This value of p varies slightly from 1·47 to 1·63 with different samples of wire, but its value can always be determined by observations at three different temperatures. Hence it is always possible to reduce the temperature as given by any specimen of wire either to the air scale or to that which would be given by some standard wire. This latter is the scale which one is almost forced to adopt when dealing with extremes of temperature. For, in the case of very low temperatures—*e.g.*, where air liquefies—the air thermometer is obviously no longer serviceable, and at very high temperatures, above 700° C., reliable experiments with the air thermometer have yet to be carried out.

The departure of the platinum scale from the air scale is not greater than the departure of the mercury scale from the air, so that those who are accustomed to accept mercury thermometer readings without hesitation will not have the order of accuracy of the observations reduced by accepting the platinum scale. In the construction of a direct-reading instrument it is obviously advantageous to have a scale divided into equal parts. The platinum scale has therefore been adopted in the direct-reading thermometer of Callender and Griffiths. This instrument is most easily described in two parts—(1) the thermometer itself, (2) the indicator.

In the thermometers, the platinum wire of ·008 in diameter is wound non-inductively on a wire formed about 2 inches in length and ⅜ths inch in diameter. In order to eliminate changes in resistance in the connecting leads, the stem of the thermometer contains four leads insulated by means of washers. Two of these are connected to the ends of the coil; the other pair, called compensators, are joined to fetters just above the coil. The lower 12 inches of these leads are of thick platinum wire; these and the coil are protected by a glazed porcelain tube. The choice of a suitable material on which to wind the coil and the complete protection of the wire from furnace gases, are both points of considerable importance. Neglect of these precautions in the earlier forms of hygrometers fully accounts for the changes which they used to undergo. The upper portion of the leads are of copper, fixed to the platinum, and insulated by being threaded through pipe stem. They are protected externally by a steel tube, which may be extended to protect the porcelain tube in cases where the thermometer is liable to rough usage. The upper ends of the copper leads terminate in four binding screws, to which the leads connecting thermometer to the indicator are attached. These connecting leads may be of any length, so long as their resistance is not much greater than ·5 ohm. The indications of the thermometer can then be read at a distance from the place under observation.

The resistance of the platinum coil is adjusted so that the change in resistance for 100° C., from ice to steam, is 1 ohm, or, in other words, each degree is equivalent to an increase in resistance of ·01 ohm. The platinum coil has therefore a resistance of 258 ohms at 0° C.

The measurements of resistance or temperature are made by means of a Wheatstone's bridge with a specially arranged galvanometer.

The two ratio arms of the bridge are made equal, and have a resistance of about 20 ohms. In the third arm of the bridge are 15

resistance coils, each of 1 ohm, and the thermometer is introduced in series with these. The fourth arm is made up of the compensating leads and a coil whose resistance is such that the whole bridge is balanced when the thermometer is at 0° C. The battery used consists of dry cells giving about 2 volts at the terminals of the bridge, so that the current through the bridge is about $\frac{1}{10}$th of an ampère.

In the galvanometer the moving portion consists of a combination of steel magnets pivoted on a needle point, and to these a light aluminium needle is attached swinging in a horizontal plane. The movement of the system is controlled by two sets of coils. These are arranged so that one pair is parallel to the pointer at the zero position of the scale, the other pair at right angles. The former pair are the equivalent of the ordinary galvanometer coils, the latter are in the direct battery circuit. Since the resistance of each arm of the bridge remains practically constant, the current which passes through the galvanometer coils will always be the same proportion to the current in the battery circuit whatever the E.M.F. of the battery may be. The deflections of the galvanometer are, therefore, independent of the strength of the battery. The adjustment of the strength of the two sets of coils is made by means of a low resistance across the field coils in the battery circuit. This is adjusted until the galvanometer swings across the scale for an increase of 1 ohm in the thermometer arm. The scale is divided into 50 parts, each representing $\frac{1}{50}$th of an ohm, or 2°. As each of these divisions are about $\frac{1}{25}$th of an inch, the scale can easily be read to 1°. For greater convenience the scale is repeated on the other side of the zero, so that the whole range of the scale without altering the resistance coils is 200°.

The resistance coils are all made of manganised wire, annealed and protected from air. There is thus no connection to be introduced for changes in temperature of the air. The instrument is also unaffected by changes in temperature of the leads to the platinum coil, for since these are in duplicate and are placed in opposite arms of the bridge, any temperature change in one pair will be balanced by the same change in the other pair. The balance of the bridge is thus only affected by the temperature changes in the coil itself. When the platinum coil has been heated through 100° it will have increased in resistance by 1 ohm, and the galvanometer pointer will be deflected across the scale. The resistance of this arm of the bridge can now be made the same as before by plugging in the 1-ohm coil, and the galvanometer returns to zero. The scale is then repeated every 100°, and thus a wide range of temperature and an open scale are obtained at the same time. The temperature is then directly read off—the hundreds of degrees by the coils plugged in, and the remainder on the scale.

A further advantage of this arrangement is that any error in the original adjustment of the swing, or want of permanence in the system, does not produce any cumulative error. A truly graduated scale would not be one of equal parts, though it is not, as might appear at first sight, a tangent scale. The error introduced by the equal scale, however, is small, and the above remark about its non-cumulative effect applies to it also.

A very common objection to this form of hygrometer is the statement that its fixed points change after exposure to high temperatures. The only answer I can give to this objection is that in the experience of those who have experimented with this form of hygrometer, its most distinguishing feature is the permanence of its fixed points. The objection is only urged by those who have no experience of the instrument, but is based on the report to the British Association in 1874, appointed to examine one particular form of instrument only. As an illustration of the permanence of the fixed points, I may give the following: One of these instruments was immersed in melted silver, the source of heat being an oxyhydrogen flame playing on the bottom of the crucible. This crucible by some means became broken, the silver poured out, and the oxyhydrogen flame was left playing directly on the lower end of the porcelain tube for some time before the accident was discovered. As a consequence the lower end of the tube became fused. On subsequent examination it was found that the wire coil and leads had become embedded in the porcelain, and it was impossible to remove the interior of the instrument. On trial in ice, however, the freezing point was found unaltered.

The porcelain tube may thus be considered as completely satisfactory in protecting the platinum coil. The difficulty of the protection of the stem is one which has not as yet been fully overcome. The difficulty is not insurmountable, as it might be met by extending the porcelain tube the whole length of the stem. Such tubes are, however, difficult to obtain, and if broken would be expensive to replace.

The second objection is the adoption of a new scale of temperature. As bearing on this point, I may quote from Callender's paper on "The Practical Measurement of Temperature in 1886:" "We at present require a practical standard to which all measurements may be directly referred; the question of its exact relation to the absolute thermo-dynamic scale may be matter for subsequent investigation, and can best be solved when we have arrived at a more accurate and extended knowledge of the phenomena of heat, of the dependencies of radiations, conductions, &c., on temperature measured in a scale, which may be to some extent arbitrary, but which will have the incalculable advantage of uniformity, so that the results of different experimentalists will be accurately comparable."

It must be borne in mind that if circumstances render it advisable to express the temperature on the air scale, the relation as given by the D formula has been established up to 700° C., and that there are indications that it holds over a far more extended range. One fact will, I think, show the accuracy of the above formula, which was determined by Callender in his exhaustive comparison with the air thermometer in 1885. In 1890 Griffiths came to the conclusion that the relation apparently established by Callender was in error at temperatures above 450° C. In assuming Regnault's value for boiling point of sulphur, 448·3, the difference between this and air temperature from the platinum temperature, as deduced by Callender's formula, was found to be about 5°. It was evident that either Callender's or Regnault's conclusions were incorrect. A redetermination of this boiling point of sulphur by direct measurement with the air thermometer was made in 1891, when it was found that the true boiling point of sulphur under a press of 700 m.m, was 444·5—a result in almost exact accordance with the temperature obtained by using platinum thermometers and the assumption of Callender's formula. It is difficult to imagine a more conclusive proof.

Evidence that this relation between the platinum and air scales also holds at very low temperature are not wanting. In a communication to the *Philosophical Magazine* by Griffiths and myself in 1892, we pointed out that if we assume that R becomes 0, and also assume that the D formula holds over such a range, the result in temperature is in the immediate neighbourhood of − 270° C. According to the experiments of Profs. Dewar and Fleming, it is at this temperature that the resistance of pure platinum should vanish.

Although there is so much evidence that the D formula is correct throughout the whole range of the platinum thermometer, still it is never safe to extrapolate beyond the range of actual experiment. I would therefore suggest that all measurement of temperature be referred to a standard platinum thermometer, in which $p = 1{\cdot}50$. There is no necessity that such a thermometer should actually exist, as it is only a matter of calculation to reduce the observed platinum temperature to the standard.

THE PHYSICAL CONDITION OF THE OCEAN.

The above is the heading of a paper recently read before the Geographical Section of the British Association at Oxford by Captain W. J. L. Wharton, R.N., F.R.S., President of the Section, which contains information of great interest to those in any way connected with submarine telegraphy.

The surface of the earth is supposed to contain 188 millions of square miles, of which 137 millions are water. It is not surprising, therefore, that except in a general way, we know but very little about the physical conditions of this vast area. Particularly since the whole of our knowledge has been gained during the last 50 years. In the eastern portion of the Central Pacific there is an area of 10,500,000 square miles, in which there are only seven soundings, whilst in a long strip crossing the whole North Pacific, with an area of 2,800,000 square miles, there is absolutely no sounding at all. Of all the oceans the Atlantic is by far the best sounded, and over its area of 31,000,000 square miles there is a mean depth of about 2,200 fathoms, or about 200 fathoms less than is considered probable is the mean depth of the Pacific.

Captain Wharton points out a fact which may be of interest to the promoters of the Pacific scheme, namely, that the very deepest parts of the ocean are not near their centres, but in all cases very near land. Thus the deepest sounding ever taken is one of 4,655 fathoms, 110 miles outside the Kurile Islands. The next deepest is 4,561 fathoms, only 70 miles north of Porto Rico, in the West Indies, and there is another deep depression with 4,175 fathoms at a distance of 50 miles off the Coast of Peru. In these great depths the bottom—we beg Captain Wharton's pardon—the *floor* of the ocean (we wonder he did not say ceiling, being a nautical man), consists of reddish-coloured clayey mud with no traces of organic remains but the teeth of sharks and cetacea. In lesser depths, say between 500 and 2,000 fathoms, small calcareous shells of the globigerinæ may be said to form by far the greater part of the oceanic floor, while in shallow water and within a certain range of land the bottom consists of terrestrial detritus.

It is perhaps of ocean currents that our knowledge is the most complete. The prime motor of surface current is the wind—the great winds which blow generally over large areas in the same direction. Mr. Clayden has made a most remarkable model of the Atlantic ocean, and he subjects the water to air blown out of various nozzles representing the mean directions of these permanent winds. The movement of the water is made apparent by lycopodium dust sprinkled over its surface, and not only are the main currents reproduced, but also the smaller effects and peculiarities of the Atlantic drifts.

When speaking of the great tidal currents, Captain Wharton mentions that their movement extends to the bottom of even the deepest water. Wave action is probably limited to a depth of 30 or 40 fathoms.

EXPERIMENTS FOR IMPROVING THE CONSTRUCTION OF PRACTICAL STANDARDS FOR ELECTRICAL MEASUREMENTS.

Report of the Committee, consisting of Prof. Carey Foster (chairman), Lord Kelvin, Profs. Ayrton, J. Perry, W. G. Adams, and Lord Rayleigh, Drs. O. J. Lodge, John Hopkinson, and A. Muirhead, Messrs. W. H. Preece and Herbert Taylor, Prof. J. D. Everett, Prof. A. Schuster, Dr. J. A. Fleming, Profs. G. F. Fitzgerald, G. Chrystal, and J. J. Thomson, Messrs. R. T. Glazebrook (secretary), W. N. Shaw, and T. C. Fitzpatrick, Dr. J. T. Bottomley, Prof. J. Viriamu Jones, Dr. G. Johnstone Stoney, Prof. S. P. Thompson, and Mr. G. Forbes.

APPENDIX.

I.—Report of the American Delegates at the Chicago Conference to the Secretary of State at Washington.

II.—Experiments on the Value of the Ohm, by J. Viriamu Jones.

III.—Comparison of the Standards employed by Prof. Jones with the Standards of the Association, by R. T. Glazebrook.

IV.—Comparison of some of the Standards of the Board of Trade with those of the Association, by J. Rennie.

V.—Values of certain Coils belonging to the Indian Government, by E. O Walker.

VI.—On the Specific resistance of Copper and of Silver, by Rev. T. C. Fitzpatrick.

VII.—On a Standard of Low Resistance, by J. Viriamu Jones.

The work of testing resistance coils at the Cavendish Laboratory has been continued. A table of the coils tested is given:—

TABLE.—OHMS.

Number of coil.	Value of coil.	Temperature, degrees.
Nalder 3,876 C.L.C. 376 ...	·99916	14
Nalder 4,320 C.L.C. 381 ...	·99922	14·1
Nalder 4,322 C.L.C. 382 ...	·99743	15·6
White C.L.C. 383 ...	1·00095	15·15
Nalder 4,087 C.L.C. 384 ...	10·0079	17·35
Paul C.L.C. 385 ...	·99993	13·7
Paul C.L.C. 386 ...	10·0041	13·7
Paul C.L.C. 387 ...	100 (1 − ·00059)	13·7
Paul C.L.C. 388 ...	1,000 (1 − ·00197)	14·2
Nalder 4,274 C.L.C. 389 ...	·100050	15·2
Nalder 4,275 C.L.C. 390 ...	·100053	15·2
Nalder 4,051 C.L.C. 391 ...	·99988	13·4
Nalder 4,338 C.L.C. 393 ...	·99902	13·6
Nalder 4,339 C.L.C. 394 ...	·99916	13·7
Nalder 4,302 C.L.C. 395 ...	·99925	14·8
Nalder 4,303 C.L.C. 396 ...	·99933	14·6
Nalder 4,304 C.L.C. 397 ...	·99933	14·6
Nalder 4,273 C.L.C. 398 ...	·99908	13·55
Nalder 4,555 C.L.C. 399 ...	·99923	13·9
Nalder 4,562 C.L.C. 400 ...	·99938	13·9
Nalder 4,556 C.L.C. 401 ...	9·9929	13·8
Nalder 4,559 C.L.C. 402 ...	9·9924	13·8
Nalder 4,563 C.L.C. 403 ...	9·9935	13·8
Nalder 4,557 C.L.C. 404 ...	100 (1 − ·00097)	14·1
Nalder 4,560 C.L.C. 405 ...	100 (1 − ·00113)	14·2
Nalder 4,564 C.L.C. 406 ...	100 (1 − ·00093)	14·1
Nalder 4,565 C.L.C. 407 ...	100 (1 − ·00003)	14·2
Nalder 4,558 C.L.C. 408 ...	1,000 (1 − ·00126)	13·9
Nalder 4,561 C.L.C. 409 ...	1,000 (1 − ·00092)	14
Nalder 4,566 C.L.C. 410 ...	1,000 (1 − ·00007)	13·9
Paul 15 C.L.C. 411 ...	·99950	14·7
Paul 27 C.L.C. 412 ...	1·00016	16·4
Paul 13 C.L.C. 413 ...	9·9973	14·8
Paul 19 C.L.C. 414 ...	10·0038	14·75
Paul 30 C.L.C. 415 ...	100 (1 − ·00091)	14·15
Paul 29 C.L.C. 416 ...	1,000 (1 − ·00094)	14·1
Burstall C.L.C. 417 ...	1·00026	13·4
Elliott 307 C.L.C. 418 ...	·99971	13·4
Nalder 4,340 C.L.C. 419 ...	1·00009	16·85
Paul 20 C.L.C. 420 ...	·99760	16·4
Paul 32 C.L.C. 421 ...	9·9997	16·5
B.A. Units.		
Elliott 87 C.L.C. 81 ...	1·00050	16·7
Muirhead C.L.C. 392 ...	·99996	13·7

The committee regret that the insulation of some of the coils referred to in their last report which had been selected for the new standards of resistance, as defined by the resolutions adopted at Edinburgh, has proved defective. Traces of acid have been discovered in the paraffin with which the coils were filled. The two one-ohm standards of the association (Report 1893, p. 3), as well as two of the one-ohm standards of the Board of Trade (Report 1892, p. 3), were found in January last to have so low an insulation resistance between the coil and the case as to be useless. Thus the labour spent in the testing of these coils has been wasted; much of it will need to be done again.

The insulation of some of the other standard-ohm coils is not satisfactory; the single-ohm standards have, therefore, been remade, and the others are being refilled with carefully selected paraffin. The original B.A. units have not, so far as comparisons between them can show, changed their values during the year, and one set of new ohm standards also have shown no sign of change.

The committee print, as an appendix to the report, the report of the proceedings at the international congress at Chicago presented to the Secretary of State at Washington by the American delegate to the conference.

During the year Prof. J. V. Jones has determined by the aid of his Lorenz apparatus the absolute resistance of certain wire coils of about ·1 ohm. These have been compared with the standard of the association by the secretary. An account of these experiments is contained in Appendices II. and III. The resistance standards of the association have been compared with those of the Board of Trade by Mr. Rennie and the secretary. Details of this comparison will be found in Appendix IV., while in Appendix V. is given by Mr. E. O. Walker an account of a comparison between five coils belonging to the Indian Government, which have been 24 years in India, and Dr. Muirhead's standards. Mr. Fitzpatrick has continued his work on the specific resistance of copper, and has drawn up a table (see Appendix VI.) reducing to the same units experimental results recently obtained by various observers. Appendix VII. contains an account of a special form of standard of low resistance devised by Prof. Jones.

In consequence of the difficulty met with in the insulation of some of the coils, it was thought well to defer the purchase of other coils for which the grant of £25 was obtained last year. The committee are of opinion that it is desirable to complete their set of standards by obtaining from Germany certified copies of the standards of the Reichsanstalt. They recommend therefore that they be reappointed, with the addition of the name of Mr. Rennie with a grant of £25; that Prof. G. Carey Foster be chairman, and Mr. R. T. Glazebrook, secretary.

APPENDIX I.

REPORT OF THE ACTION OF THE INTERNATIONAL ELECTRICAL CONGRESS HELD IN CHICAGO, AUGUST, 1893, IN THE MATTER OF UNITS OF ELECTRICAL MEASURE.

Washington, D.C., *November 6th*, 1893.

The Hon. W. Q. Gresham,
Secretary of State, Washington, D.C.

Sir,—The undersigned, having been designated by you on May 12th, 1893, as delegates to represent the United States in the International Electrical Congress to be held in August at Chicago, beg to submit herewith a brief report, showing the definitive action of said congress in the matter of defining and naming units of electrical measure. The consideration of this important subject was left to what was known as the "Chamber of Delegates" of the congress, consisting only of those who had been officially commissioned by their respective governments to act as members of said Chamber. After conference and correspondence with the leading electricians of Europe, it had been agreed that the maximum number of such delegates to be allowed to one nation should be five, and this number was allotted to the United States, Great Britain, Germany and France. Other nations were allowed three or two, and in some instances one. Delegates present and taking part in the discussions and action of the Chamber were as follows:—

Representing the United States.—Prof. H. A. Rowland, Johns Hopkins University, Baltimore, Md.; Dr. T. C. Mendenhall, superintendent of U.S. Coast and Geodetic Survey, and of Standard Weights and Measures, Washington, D.C.; Prof. H. S. Carhart, University of Michigan, Ann Arbor, Mich.; Prof. Elihu Thomson, Lynn, Mass.; Dr. E. L. Nichols, Cornell University, Ithaca, N.Y.

Representing Great Britain.—W. H. Preece, F.R.S., engineer-in-chief and electrician, Post Office, England, president of the Institution of Electrical Engineers, London; Prof. W. E. Ayrton, F.R.S., City and Guilds of London Central Institution, Exhibition Road, London; Prof. Silvanus P. Thompson, D.Sc, F.R.S., principal of the City and Guilds Technical College, Finsbury, London; Alex. Siemens, 12, Queen Anne's Gate, Westminster, London, S.W.

Representing France.—E. Mascart, Membre de l'Institute, 176, Rue de l'Université, Paris; T. Violle, professeur au Conservatoire des Arts et Métiers, 89, Boulevard St. Michel, Paris; De la Touanne, telegraph engineer of the French Government, 13, Rue Soufflet, Paris; Edouard Hospitalier, professeur à l'Ecole de Physique et de Chimie Industrielle de la Ville de Paris; Vice-president de la Société Internationale des Eléctriciens, 6, Rue de Clichy, Paris; Dr. S. Leduc, 5, Quai Fosse, Nantes.

Representing Italy.—Comm. Galileo Ferraris, professor of technical physics and electrotechnics in the R. Museo Industriale, Turin, Via Venti Settembre, 46.

Representing Germany.—H. E. Hermann von Helmholtz, prisident der Physikalisch-technischen Reichsanstalt, professor a. d. Universität, Berlin, Charlottenburg bei Berlin; Dr. Emil Budde, Berlin, N.W., Klopstockstrasse 53; A. Schräder, Regierungsrath, Mitglied des Kaiserl. Patentamts, Berlin; Dr. Ernst Voit, professor an der technischen Hochschule, München, Schwanthalerstrasse 73-3; Dr. Otto Lummer, Mitglied der Physikalisch-technischen Reichsanstalt, Charlottenburg, Berlin.

Representing Mexico.—Augustin W. Chavez, city of Mexico.

Representing Austria.—Dr. Johann Sahulka, Technische Hochschule, Wien.

Representing Switzerland.—A. Palaz, professeur, Lausanne; René Thury, ingénieur, Florissant, Genève.

Representing Sweden.—M. Wennman, Byrachef i Rougle Telegrafstyrelsen, Stockholm.

Representing British North America.—Ormond Higman, electrician, Standards Branch, Inland Revenue Department, Ottawa.

His Excellency, Dr. H. von Helmholtz, was made honorary president of the Congress; Dr. Elisha Gray, of Chicago, was chairman of the General Congress, and Prof. H. A. Rowland, of Baltimore, was president of the Chamber of Delegates.

Meetings of the chamber continued during six days, at the end of which its members unanimously agreed in the adoption of the following resolution:—

Resolved, That the several governments represented by the delegates of this International Congress of Electricians be, and they are hereby, recommended to formally adopt as legal units of electrical measure the following: As a unit of resistance, the *international ohm*, which is based upon the ohm equal to 10^9 units of resistance of the C.G.S. system of electro-magnetic units, and is represented by the resistance offered to an unvarying electric current by a column of mercury at the temperature of melting ice 14·4521 grammes in mass, of a constant cross-sectional area, and of the length of 106·3 centimetres.

As a unit of current, the *international ampère*, which is one-tenth of the unit of current of the C.G.S. system of electro-magnetic units, and which is represented sufficiently well for practical use by the unvarying current which, when passed through a solution of nitrate of silver in water, and in accordance with accompanying specifi-

cation,* deposits silver at the rate of 0·001118 of a gramme per second.

As a unit of E.M.F., the *international volt*, which is the E.M.F. that, steadily applied to a conductor whose resistance is 1 international ohm, will produce a current of 1 international ampère, and which is represented sufficiently well for practical use by $\frac{1000}{1434}$ of the E.M.F. between the poles or electrodes of the voltaic cell known as Clark's cell, at a temperature of 15° C., and prepared in the manner described in the accompanying specification.†

As a unit of quantity, the *international coulomb*, which is the quantity of electricity transferred by a current of 1 international ampère in one second.

As a unit of capacity, the *international farad*, which is the capacity of a condenser charged to a potential of 1 international volt by 1 international coulomb of electricity.

As a unit of work, the *joule*, which is equal to 10^7 units of work in the C.G.S. system, and which is represented sufficiently well for practical use by the energy expended in one second by an international ampère in an international ohm.

As a unit of power, the *watt*, which is equal to 10^7 units of power in the C.G.S. system, and which is represented sufficiently well for practical use by the work done at the rate of 1 joule per second.

As the unit of induction, the *henry*, which is the induction in a circuit when the E.M.F. induced in this circuit is 1 international volt, while the inducing current varies at the rate of 1 ampère per second.

The chamber also voted that it was not wise to adopt or recommend a standard of light at the present time.

A more complete report of the operations of the chamber will shortly be forwarded. This brief *résumé* of its definite action in reference to the matter of units is now submitted to facilitate the prompt dissemination among representatives of foreign governments of the important results of a congress of whose success and fruitfulness the United States may justly be proud.

H. A. Rowland. Elihu Thomson.
T. C. Mendenhall. E. L. Nichols.
H. S. Carhart.

APPENDIX II.

On a Determination of the International Ohm in Absolute Measure.

By Prof. J. V. Jones, F.R.S., Principal of the University College of South Wales and Monmouthshire, Cardiff.

The apparatus for the absolute measurement of the actual resistance in my laboratory at Cardiff was completed in 1890, and I first used it for the determination of the specific resistance of mercury in absolute measure (*Phil. Trans.*, 1891, A). This determination was made by direct measurement on a mercury column contained in a trough of paraffin wax. The results of five complete sets of observations were as follows:—

94103
94074
94093
94045
94021

The mean of these is 94067; and the extreme variation from the mean is 46, or about four parts in 10,000.

I suspected that much of the variation was due to the paraffin trough, the temperature of which varied slightly (about half a degree) during the observations, and was not accurately measurable owing to the low conductivity of the material. With variation of temperature there was variation of breadth, and the breadth of the trough entered as a primary factor into the calculation of the specific resistance.

When I proceeded to use the apparatus for the measurement of low resistance standards of solid metal this was conclusively shown to be the case. I brought a set of measurements made on such a standard under the attention of the section last year (at Nottingham), in which the extreme variation from the mean was only about one part in 12,000.

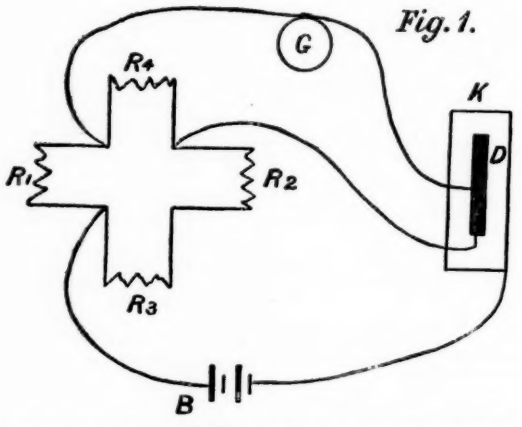
This may be taken to be the normal performance of the apparatus, and seeing that it is an instrument of such precision it seemed to me of interest to determine by the use of solid metal standards the relation between its indications and the results obtained by other observers for the value of the ohm.

With this end in view I obtained four coils from Messrs. Nalder Bros.—two platinum-silver 10-ohm coils, and two manganine 10-ohm coils. Mr. Glazebrook has measured them in terms of the international ohm; and I am much indebted to him for the pains he has been kind enough to take in making the determination. The following table gives their resistances and temperature coefficients:—

Coil number.	Resistance in I. O. (Glazebrook).	Temperature coefficient (Nalder).
3,873	9·9919 at 14° 8 C.	·000300
3,874	9·9926 „ 14° 9 C.	·000276
4,274	·100050 „ 15° 2 C.	·000013
4,275	·1000053 „ 15° 2 C.	·000013

These coils were arranged in manner similar to that adopted by Lord Rayleigh in his determination of the ohm by the method of Lorenz (see Fig. 1). If there is no current through the galvanometer, there

Fig. 1.



R1, R3, Ten ohm coils; R2, R4, Tenth ohm coils; G, Galvanometer; B, Battery R, Standard coil; D, Rotating disc.

is equality between the E.M.F. due to the rotation of the disc in the field of the standard coil and the E.M.F. due to the current through R_4; and we have, if R_1, R_2, R_3, R_4 are the values of the four resistance coils in international ohms, and if x is the value of the international ohm in absolute measure,

$$\frac{R_2 R_4 x}{R_1 + R_2 + R_3 + R_4} = M n,$$

where M = the coefficient of mutual induction of the standard coil and the circumference of the disc, and N = the rate of rotation of the disc.

The resistance coils are of B.A. pattern. They were immersed in water, and the temperatures of the thermometers within the coil frames were read before and after each observation. A wooden box surrounded the four cans containing the coils.

The method of making the observations was the same as that described in the paper I read before the section last year (*vide* Electrical Standards Committee report, 1893). In making them the rate of rotation of the disc is controlled with reference to a tuning-fork with riders electrically maintained in vibration, and it is measured on the tape of a Bain's electro-chemical telegraph receiver, on which the make and break of a platinum wire on a mercury-cup worked by an eccentric lever attached to the axle record the turns of the disc side-by-side with the time record of the laboratory clock.

At the same time, the observer at the galvanometer continually reverses the direction of the main current, and calls out the corresponding galvanometer readings. As a result, we have for each set of observations:—

(1) The temperatures of the coils.
(2) The rate of rotation of the disc.
(3) The change of galvanometer ready consequent on reversal of the current obtained as the mean from a number of reversals proportional to the time during which the observation lasts. This time has, in the observations to be brought before the section to-day, been either one minute or three minutes—generally three.

(To be continued.)

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* In the following specification the term silver voltameter means the arrangement of apparatus by means of which an electric current is passed through a solution of nitrate of silver in water. The silver voltameter measures the total electrical quantity which has passed during the time of the experiment, and by noting this time the time average of the current, or if the current has been kept constant, the current itself, can be deduced. In employing the silver voltameter to measure currents of about 1 ampère, the following arrangements should be adopted: The cathode on which the silver is to be deposited should take the form of a platinum bowl not less than 10 centimetres in diameter and from 4 to 5 centimetres in depth. The anode should be a plate of pure silver some 30 square centimetres in area and 2 or 3 millimetres in thickness. This is supported horizontally in the liquid near the top of the solution by a platinum wire passed through holes in the plate at opposite corners. To prevent the disintegrated silver which is formed on the anode from falling on to the cathode, the anode should be wrapped round with pure filter paper, secured at the back with sealing-wax. The liquid should consist of a neutral solution of pure silver nitrate, containing about 15 parts by weight of the nitrate to 85 parts of water. The resistance of the voltameter changes somewhat as the current passes. To prevent these changes having too great an effect on the current, some resistance besides that of the voltameter should be inserted in the circuit. The total metallic resistance of the circuit should not be less than 10 ohms.

† A committee, consisting of Messrs. Helmholtz, Ayrton, and Carhart, was appointed to prepare specifications for the Clark's cell. Their report has not yet been received.

BOARD OF TRADE AND ELECTRICAL MEASUREMENTS.

Last Friday's issue of the *London Gazette* contained the following declaration of Her Majesty the Queen, made at the Court at Osborne House, on 23rd inst.:—

Whereas by "The Weights and Measures Act, 1889," it is among other things enacted that the Board of Trade shall from time to time cause such new denominations of standards for the measurement of electricity as appear to them to be required for use in trade to be made and duly verified.

And whereas it has been made to appear to the Board of Trade that new denominations of standards are required for use in trade based upon the following units of electrical measurement, viz.:—

1. The ohm, which has the value 10^9 in terms of the centimetre and the second of time and is represented by the resistance offered to an unvarying electric current by a column of mercury at the temperature of melting ice 14·4521 grammes in mass of a constant cross sectional area and of a length of 106·3 centimetres.

2. The ampère, which has the value $\frac{1}{10}$th in terms of the centimetre, the gramme and the second of time, and which is represented by the unvarying electric current, which, when passed through a solution of nitrate of silver in water in accordance with the specification appended hereto and marked A deposits silver at the rate of 0·001118 of a gramme per second.

3. The volt which has the value 10^8 in terms of the centimetre the gramme and the second of time, being the electrical pressure that if steadily applied to a conductor whose resistance is 1 ohm will produce a current of 1 ampère, and which is represented by ·6974 ($\frac{1000}{1434}$) of the electrical pressure at a temperature of 15° C. between the poles of the voltaic cell known as Clarks' cell set up in accordance with the specification appended hereto and marked B.

And whereas they have caused the said new denominations of standards to be made and duly verified.

Now, therefore, Her Majesty, by virtue of the power vested in her by the said Act, by and with the advice of her Privy Council, is pleased to approve the several denominations of standards set forth in the schedule hereto as new denominations of standards for electrical measurement.

(Signed) C. L. Peel.

Schedule.

I.—*Standard of Electrical Resistance.*

A standard of electrical resistance denominated 1 ohm being the resistance between the copper terminals of the instrument marked "Board of Trade ohm standard verified, 1894" to the passage of an unvarying electrical current when the coil of insulated wire forming part of the aforesaid instrument and connected to the aforesaid terminals is in all parts at a temperature of 15·4 C.

II.—*Standard of Electrical Current.*

A standard of electrical current denominated 1 ampère being the current which is passing in and through the coils of wire forming part of the instrument marked "Board of Trade ampère standard verified, 1894," when, on reversing the current in the fixed coils the change in the forces acting upon the suspended coil in its sighted position is exactly balanced by the force exerted by gravity in Westminster upon the iridio-platinum weight marked A, and forming part of the said instrument.

III.—*Standard of Electrical Pressure.*

A standard of electrical pressure denominated 1 volt being $\frac{1}{100}$th part of the pressure, which, when applied between the terminals, forming part of the instrument marked "Board of Trade volt standard verified, 1894," causes that rotation of the suspended portion of the instrument which is exactly measured by the coincidence of the sighting wire the image of the fiducial mark A before and after application of the pressure, and with that of the fiducial mark B during the application of the pressure, these images being produced by the suspended mirror and observed by means of the eye-piece.

In the use of the above standards the limits of accuracy attainable are as follows:—

For the ohm, within $\frac{1}{100}$th part of 1 per cent.
For the ampère, within $\frac{1}{10}$th part of 1 per cent.
For the volt, within $\frac{1}{10}$th part of 1 per cent.

The coils and instruments referred to in this schedule are deposited at the Board of Trade Standardising Laboratory, 8, Richmond Terrace, Whitehall, London.

Specifications referred to in the foregoing order in council:—

Specification A.

In the following specification the term silver voltameter means the arrangement of apparatus by means of which an electric current is passed through a solution of nitrate of silver in water. The silver voltameter measures the total electrical quantity which has passed during the time of the experiment, and by noting this time the time average of the current, or if the current has been kept constant the current itself can be deduced.

In employing the silver voltameter to measure currents of about 1 ampère the following arrangements should be adopted. The cathode on which the silver is to be deposited should take the form of a platinum bowl not less than 10 centimetres in diameter, and from 4 to 5 centimetres in depth.

The anode should be a plate of pure silver some 30 square centimetres in area and 2 or 3 millimetres in thickness.

This is supported horizontally in the liquid near the top of the solution by a platinum wire passed through holes in the plate at opposite corners. To prevent the disintegrated silver which is formed on the anode from falling on to the cathode, the anode should be wrapped round with pure filter paper, secured at the back with sealing wax.

The liquid should consist of a neutral solution of pure silver nitrate, containing about 15 parts by weight of the nitrate to 85 parts of water.

The resistance of the voltameter changes somewhat as the current passes. To prevent these changes having too great an effect on the current, some resistance besides that of the voltameter should be inserted in the circuit. The total metallic resistance of the circuit should not be less than 10 ohms.

Method of Making a Measurement.

The platinum bowl is washed with nitric acid and distilled water dried by heat, and then left to cool in a desiccator. When thoroughly dry it is weighed carefully.

It is nearly filled with the solution, and connected to the rest of the circuit by being placed on a clean copper support to which a binding screw is attached. This copper support must be insulated.

The anode is then immersed in the solution so as to be well covered by it and supported in that position; the connections to the rest of the circuit are made.

Contact is made at the key, noting the time of contact. The current is allowed to pass for not less than half-an-hour, and the time at which contact is broken is observed. Care must be taken that the clock used is keeping correct time during this interval.

The solution is now removed from the bowl and the deposit is washed with distilled water and left to soak for at least six hours. It is then rinsed successively with distilled water and absolute alcohol and dried in a hot-air bath at a temperature of about 160° C. After cooling in a desiccator it is weighed again. The gain in weight gives the silver deposited.

To find the current in ampères, this weight, expressed in grammes, must be divided by the number of seconds during which the current has been passed, and by 0·001118.

The result will be the time-average of the current, if during the interval the current has varied.

In determining by this method the constant of an instrument the current should be kept as nearly constant as possible, and the readings of the instrument observed at frequent intervals of time. These observations give a curve from which the reading corresponding to the mean current (time-average of the current), can be found. The current, as calculated by the voltameter, corresponds to this reading.

Specification B.

On the Preparation of the Clark Cell.

Definition of the Cell.

The cell consists of zinc or an amalgam of zinc with mercury and of mercury in a neutral saturated solution of zinc sulphate and mercurous sulphate in water, prepared with mercurous sulphate in excess.

Preparation of the Materials.

1. *The Mercury.*—To secure purity it should be first treated with acid in the usual manner, and subsequently distilled in vacuo.

2. *The Zinc.*—Take a portion of a rod of pure redistilled zinc, solder to one end a piece of copper wire, clean the whole with glass paper or a steel burnisher, carefully removing any loose pieces of the zinc. Just before making up the cell dip the zinc into dilute sulphuric acid, wash with distilled water, and dry with a clean cloth or filter paper.

3. *The Mercurous Sulphate.*—Take mercurous sulphate, purchased as pure, mix with it a small quantity of pure mercury, and wash the whole thoroughly with cold distilled water by agitation in a bottle; drain off the water, and repeat the process at least twice. After the last washing, drain off as much of the water as possible.

4. *The Zinc Sulphate Solution.*—Prepare a *neutral* saturated solution of pure ("pure re-crystallised") zinc sulphate by mixing in a flask distilled water with nearly twice its weight of crystals of pure zinc sulphate, and adding zinc oxide in the proportion of about 2 per cent. by weight of the zinc sulphate crystals to neutralise any free acid. The crystals should be dissolved with the aid of gentle heat, but the temperature to which the solution is raised should not exceed 30 degrees C. Mercurous sulphate, treated as described in 3, should be added in the proportion of about 12 per cent. by weight of the zinc sulphate crystals to neutralise any free zinc oxide remaining, and the solution filtered, while still warm, into a stock bottle. Crystals should form as it cools.

5. *The Mercurous Sulphate and Zinc Sulphate Paste.*—Mix the washed mercurous sulphate with the zinc sulphate solution, adding sufficient crystals of zinc sulphate from the stock bottle to ensure saturation, and a small quantity of pure mercury. Shake these up well together to form a paste of the consistence of cream. Heat the paste, but not above a temperature of 30° C. Keep the paste for an hour at this temperature, agitating it from time to time, then allow it to cool; continue to shake it occasionally while it is cooling. Crystals of zinc sulphate should then be distinctly visible, and should be distributed throughout the mass; if this is not the case add more crystals from the stock bottle, and repeat the whole process.

This method ensures the formation of a saturated solution of zinc and mercurous sulphates in water.

To set up the Cell.

The cell may conveniently be set up in a small test tube of about 2 centimetres diameter, and 4 or 5 centimetres deep. Place the mercury in the bottom of this tube, filling it to a depth of say ·5 centimetres. Cut a cork about ·5 centimetres thick to fit the tube; at one side of the cork bore a hole through which the zinc rod can pass tightly; at the other side bore another hole for the glass tube which covers the platinum wire; at the edge of the cork cut a nick through which the air can pass when the cork is pushed into the tube. Wash

the cork thoroughly with warm water, and leave it to soak in water for some hours before use. Pass the zinc rod about 1 centimetre through the cork.

Contact is made with the mercury by means of a platinum wire about No. 22 gauge. This is protected from contact with the other materials of the cell by being sealed into a glass tube. The ends of the wire project from the ends of the tube; one end forms the terminal, the other end and a portion of the glass tube dip into the mercury.

Clean the glass tube and platinum wire carefully, then heat the exposed end of the platinum red hot, and insert it in the mercury in the test tube, taking care that the whole of the exposed platinum is covered.

Shake up the paste and introduce it without contact with the upper part of the walls of the test tube, filling the tube above the mercury to a depth of rather more than 1 centimetre.

Then insert the cork and zinc rod passing the glass tube through the hole prepared for it. Push the cork gently down until its lower surface is nearly in contact with the liquid. The air will thus be nearly all expelled, and the cell should be left in this condition for at least 24 hours before sealing, which should be done as follows:—

Melt some marine glue until in is fluid enough to pour by its own weight, and pour it into the test tube above the cork, using sufficient to cover completely the zinc and soldering. The glass tube containing the platinum wire should project some way above the top of the marine glue.

The cell may be sealed in a more permanent manner by coating the marine glue, when it is set, with a solution of sodium silicate, and leaving it to harden.

The cell thus set up may be mounted in any desirable manner. It is convenient to arrange the mounting so that the cell may be immersed in a water bath up to the level of, say, the upper surface of the cork. Its temperature can then be determined more accurately than is possible when the cell is in air.

In using the cell sudden variations of temperature should, as far as possible, be avoided.

The form of the vessel containing the cell may be varied. In the H form, the zinc is replaced by an amalgam of 10 parts by weight of zinc to 90 of mercury. The other materials should be prepared as already described. Contact is made with the amalgam in one leg of the cell, and with the mercury in the other, by means of platinum wires sealed through the glass.

NEW PATENTS—1894.

15,364. "Improvements in and connected with the methods of and devices for the utilisation of waste steam." J. Wild. Dated August 13th.

15,376. "Improvements in holders for globes or shades of electric gas or other lamps." J. Whitehead. Dated August 13th.

15,396. "Improvements in electric tramways." J. Hopkinson. Dated August 13th.

15,403. "Improvements in automatic alarm devices for use in connection with telephones and microphones." C. H. Krutzfeldt. Dated August 13th. (*Complete.*)

15,414. "Improvements in telephone annunciators and call bells." F. G. Warrell. Dated August 13th. (*Complete.*)

15,424. "Improvements in electro-motors." D. Cook. Dated August 14th.

15,429. "Improvements in conducting and economising electricity." J. Lindley and G. E. Sutcliffe. Dated August 14th.

15,452. "Improvements in electric arc-lamps." H. H. Lake. (Communicated by R. Drysdale, United States.) Dated August 14th. (*Complete.*)

15,455. "Improvements in telegraphic transmitters." F. F. Howe. Dated August 14th. (*Complete.*)

15,506. "Improvements relating to voltmeters, which are applicable to amperemeters." F. Brown. Dated August 15th. (*Complete.*)

15,533. "Improvements in and relating to the adaptation of telephonic sounds and the motion of the appendages to mechanical figures and to tables, boxes, and other articles of furniture." T. J. Howell and F. Lake. Dated August 15th.

15,573. "A new method of utilising running vehicles and machinery for the production and storage of electric force." J. T. Cathcart. Dated August 16th.

15,575. "Improvements in gasaliers, electroliers, and pendants, which are also applicable for oil or spirit lamps." C. Smith. Dated August 16th.

15,600. "An improved form of electrically heated curling-tongs." O. March and A. Winterbottom. Dated August 16th.

15,617. "Improvements in apparatus for registering the number or duration of telephonic conversations." A. Munch. Dated August 16th.

15,632. "Improvements in methods of and apparatus for heating crucibles by means of electricity." A. C. Girard and E. A. G. Street. [Date applied for under Patents, &c., Act, 1883, Sec. 103, February 19th, 1894, being date of application in France.] Dated August 16th.

15,675. "An improved vehicle to be used on ordinary roads and propelled by electricity." E. S. Colchester. Dated August 17th.

15,694. "Improvements in or relating to electric arc lamps." E. H. Maret. Dated August 17th.

15,698. "Improvements in electric appliances for boiling or heating liquids." F. W. Schindler. Dated August 17th.

15,712. "Improvements in what are known as dry voltaic cells or batteries." D. B. Morison. Dated August 17th.

15,722. "Variable speed gear." L. Tolch. Dated August 18th.

15,737. "Improvements in phonographs." A. Wilkinson. Dated August 18th.

15,770. "Improvements in electric-heating apparatus." J. A. Kingdon. Dated August 18th.

15,774. "Improvements in electric cables." H. A. C. Saunders. (Communicated by R. Greey and W. J. Murphy.) Dated August 18th.

15,782. Improvements in the manufacture of carbon for electrical and other purposes." C. P. Shrewsbury, F. L. Marshall, J. Cooper, and J. L. Dobell. Dated August 18th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1893.

10,597. "Improvements in devices for adapting electric lamps to ordinary candle fittings and the like." G. S. Sluce. Dated May 30th. Claims:—1. In electric candle fittings the combination and arrangement of parts particularly specified whereby the compression of a piece of elastic material is made use of to fix an electric candle fitting to its socket. 2. In electric candle fittings the use of a tube in conjunction with a compressable material to provide a method of fixture.

13,647. "Improvements relating to galvanometers." C. L. R. E. Menges. Dated July 13th. The inventor constructs a galvanometer with two coils arranged side by side with a space between, and fixes the controlling magnet in the neutral space between the same, the moving magnetic needles being placed inside the coils. 5 claims.

13,672. "Improvements in apparatus for transmitting telegraphic indicating and other analogous signals or movements by means of electric currents." A. B. Brown and W. F. King. Dated July 14th. Relates to telegraphic indicating and other analogous apparatus in which signals or movements are transmitted through a greater or less distance by means of electric currents operating on an electro-magnet or magnets, which is, or are, caused to operate on an escapement wheel or other analogous device, causing it to turn with its pointer attached to the message or signal which is required to be transmitted; and it has for its object to apply to such apparatus devices for ensuring the accurate correspondence of the sending and receiving instruments by automatically resetting the apparatus once or twice during each revolution. 1 claim.

13,749. "Improved means of working and controlling electric elevators." M. Holroyd Smith. Dated July 15th. Relates to electric elevators where the motor is stationary, operating the cage through the medium of ropes, chains, racks, screws, rams or equivalent devices. 2 claims.

13,792. "Fluid-operated electric switches." J. J. P. Clariot. Dated July 15th. Relates to fluid-operated electric switches for controlling, i.e., closing, breaking, varying, or distributing, electric currents from a distance without the use of conducting wires between the switch and the distant points, whence it is operated, whereby the consequences of imperfect insulation, and the danger of sparking, are avoided since the apparatus, which is liable to heating or sparking may be fixed at a distance from inflammable structures and be operated from any number of distinct points either simultaneously or separately. 4 claims.

14,271. "Improvements in the method of distributing electricity through sub-stations, and in apparatus for that purpose." C. Bertram and W. J. Hope-Johnstone. Dated July 24th. The object of the invention is to provide means of changing at the generating station the transformer connected to the dynamo and thereby changing the secondary mains at the sub-station to the secondary terminals of the same transformer, whenever the measuring instruments at the generating station indicate that the demand has fallen below a certain fraction of the capacity of the transformer then in circuit, or risen above the capacity it is intended to convert.

14,533. "Improvements in supplying electrical energy to motor vehicles on electric railways and to electromotors on vessels by means of alternate current transformers." Siemens Bros. & Co., Ltd. (Communicated from abroad by Messrs. Siemens & Halske, of Berlin.) Dated July 28th. Consists in applying to the working of electric railways and the electric propulsion of vessels on water, the construction of transformers for working with varying loads, described in specification No. 19,821, of 1892. 2 claims.

14,715. "Improvements in pulls and pushes for electric bells." E. G. Harcourt. Dated August 1st. Consists of a pneumatic cylinder device containing a piston, which piston is pulled out by a suitable knob or handle in such manner that the electric bell begins to ring when the handle is pulled out and remains ringing while the said piston impelled by a spring returns in the pneumatic cylinder. 4 claims.

15,510. "Improvements in electric arc lamps." J. Brockie. Dated August 15th. Relates to an improvement on Patent No. 4,419, of 1882. The inventor fixes on the pawl lever of the lamp a spring faced with soft material which bears on the edge of the wheel so as to act as a brake when the wheel is released by the pawl, and thus to make the feed of the carbon gradual. 3 claims.